

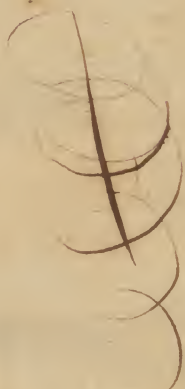


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CHURCH OF THE HOLY TRINITY

of the City of New York

1871

1871

CHEMICAL LECTURES

By

D^R IRVINE.

VOLUME II.

THE HISTORY OF THE
CITY OF LONDON

IN

THE
CITY OF LONDON

THE HISTORY OF THE
CITY OF LONDON

COMPOUND SALTS

The Compound salts are formed by the union of the simple salts, from which circumstance they might be expected to be very numerous, for by combining variously the nine simple salts we might produce 362880 different compounds but as salts of one class only, unite with those of the other L^2 do not unite with L^2 nor X^2 w^t X^2 , nor do X^2 unite with more than one L at a time & that in a certain proportion upon all these accounts their number is limited to eighteen four of which have not been applied to any purpose or distinguished by any name. The proportion in which X^2 unite w^t L^2 is generally thought to be equal parts of each, but this is liable to objection, for though this may be the case with regard to some, it is not so with all of them. When an x is added to an L in such proportion as that neither of them may prevail they form what has been generally called a Sal Medium or Neutralis, but the name of Sal composuitus, or compound salt is better than any of them.

There are three methods when we mix together an

+ and L, of hitting the point of saturation. The 1st is to observe when the effervescence ceases, to promote which they ought to be stirred or agitated during their union. The 2^d way is by the taste we know X^o has a sour & L^o a urinous flavour, therefore when the compound has neither of these the are said to be saturated. But as both of these are in some degree faulty, I would recommend the 3^d method, by using the Test paper.

Compound Salts differ very greatly from their ingredients. The last are almost always in a fluid form especially the X^o, & the L^o especially the vegetable & is very deliquescent, & never in the form of regular crystals; now L^o & X^o when united have their attraction for water lessened, & on that account they crystallize regularly. They differ likewise remarkably as to their effects on the human body, X^o particularly the fossile are corrosive & poisonous, & in this respect the L^o are nearly similar; but their compounds are so mild as to be taken into the body without any harm.

Some of these compound Salts are found ready formed in nature, the rest of them are the produce of art. The first of these are ^{not} very numerous but their quantity is large. The others are very numerous.

A TABLE OF SALTS.

<i>Acida Fossilia</i>				<i>Acida Vegetabilia</i>		
<i>Acid. Vitriol.</i>	<i>Acid. Nitros.</i>	<i>Acid. Mariat.</i>	<i>Acetum.</i>	<i>Tartarum.</i>	<i>Sal Sedat.</i>	
<i>Alkali Fixum Fossile.</i>	<i>Sal Glauberi</i>	<i>Nitrum Cubicum</i>	<i>Sal Communis</i>		<i>Sal Ruspellensis</i>	<i>Borax</i>
<i>Alkali Fixum Vegetabile</i>	<i>Tartarum Vitriolatum</i>	<i>Nitrum</i>	<i>Sal Digestivus</i>	<i>Tartarum Regeneratum</i>	<i>Tartarum Tartarizatum</i>	
<i>Alkali Volatile</i>	<i>Ammoniacus Nitrosatus</i>	<i>Ammoniacus Nitrosus</i>	<i>Sal Ammoniacus</i>	<i>Spiritus Mindereri</i>		

SYNONEMA.

Acidum Vitriolicum	Sal Sedativus vel	Tartarum Vitriolatum
Oleum Vitrioli	Narcoticus Stombergii.	Sal. polyotresus
Spiritus Vitrioli	Alkali fixum fofile	Nitrum Vitriolatum
Acidum Sulphureum	Nation.	Sal de Duobus
Ol. Sulph. p ^o Campanum	Aphronitrum	Ammoniacus Vitriolatus
Spiritus Aluminis.	Alkali fixum Vegetabile	Sal Ammon. Surt. Glauc
Acidum Calcanthi	Sal Absynthii.	Nitrum Cubicum
— Simogeneum	Sal Tartari	— Quadrangulare
— Caltharicum	Nitrum fixum	Nitrum
— Univerfalis	Cineres Clavellae	Sal petrae
— Aereum	Aqua Solutum	Ammoniacus Nitrosum
— Vagum fofile	Ol. Tart. p ^o deliquium	Nitrum Semivolatile
Acidum Nitrosum	Sixivium Tartari.	Sal Communis
Spiritus Nitri.	Alkali Volatile	— Gemmae
Sp. Nitri Glauberi.	Sal. Ammon. Volatile	— Marinus
Aqua fortis.	— Coram Corvi.	Sal Digestivus vel
Acidum Moniacum	— Urinae	Schiffusque Sylvii.
Spiritus Salis	Aqua Solutum	Sal Maris regeneratus
— Glauberis	Sp. Sal. Ammoniac.	Sp. Sal. Mar. Coagulatus
Acetum	— Cornu Corvi.	Tartarus Regeneratus
Spiritus aceti	— Urinae	Sal Diureticus
Acetum Destillatum	— Fuliginis.	Terra foliata Tartari
Tartarum	Sal Glauberi.	Sal Repellentis
Crystalli Tartari	— Catharticus vel	Polychrestus repellentis
Cremor Tartari	Mirabile Glauberi.	Sal Sugnette
		Prochelles.
		Tartarus Tartarizatus
		— Solubile

11/11/11

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As Chemists in their experiments often prepared the same salt from different substances, therefore many of these salts have no less than a dozen of names. We ought therefore to be perfectly acquainted with all those synonyma. I have always made it my practice to exhibit a table so as by it we shall know what kind of salt one particular \times will form with an α . This table also exhibits all the different synonyma.

In this table I have placed the \times in the order of their attraction for α , & the α in the order of their attraction for \times . Thus the \oplus separates ~~separates~~ ~~and~~ the other α from the α wherewith they may be combined. & is therefore placed at the top of the first column. The fopile & vegetable δ are placed in the same column as their attraction for \times is nearly the same. The uses of this table are the following. Suppose I want to know what salt will be formed by the union of the \oplus & veg δ , I find the α at the side column passing my eye horizontally along I find under the column of the \oplus the salt Nitram. Another use of it is to shew what are the ingredients of any salt; Suppose for example it is common salt which I find out, & at the top of the column I find the \oplus , & at the side, the fopile δ .

Another purpose of it is to shew what will be the consequence of adding to a compound any simple salt.

If I add to a compound salt any \times that has a stronger attraction for its Δ than the \times with which it is combined, the \times that has the weakest attraction will be separated, & the other \times will unite with the Δ & form a new compound. Thus for example

I want to know the consequence of adding to common salt the Θ . I look & see that the Θ stands nearer the beginning of the table than the Θ is the basis of common salt, therefore it will separate the Θ & uniting with the Δ form Glauber's salt. — Again suppose I mix with with

Θ the Θ . I know that the former is composed of the Θ & the vegetable Δ , therefore as the Θ stands nearer the beginning of the table than the Θ , no effect will be produced. Besides these uses of this table, the synonyma of the different salts are also set down. You must therefore know this table perfectly & readily, & be able to tell in a minute the ingredients &c of the different salts, otherwise you will be often at a very great loss.

Having said these things in general I now

proceed to the compound salts in particular: & shall begin with those formed by the union of the Δ & vegetable & fossile α . These are Sal Glauberi & Tartarus Vitriolatus. The first of these got its name from Glauber the chemist who first made it, the last got its name from its ingredients viz the Δ & the vegetable & the purest kind of which is got from Tartar. These salts have the same \times in their composition, or chemically speaking for their basis, but their α 's are different. They are the most ~~fixed~~ ^{fixed} of all the salts, & their ingredients cannot be separated by any \times or whatever therefore it was long unknown & proposed as a problem by Stahl how they might be separated. It is now known that this may be done by elective attraction the \times having a stronger attraction for the Δ than ^{for} the α . If therefore you add to either of these salts a quantity of charcoal dust, the \times will quit the α and unite with the Δ form sulphur which uniting with the α forms a liquor, but as the sulphur has less attraction for the α than any of the \times 's, if we add a vegetable \times we get the α free from the sulphur, & by heating the compound red hot we get it perfectly pure. It may therefore

be imagined that the Δ is more strongly attracted by x^s than α^s are but tho' this holds true with regard to the Δ , it is not the case with all of them.

Sal Glauberis.

The crystals of this salt have always a degree of transparency, & more so than any other salt; they are of a prismatic form, & contain about half their weight of water. This salt undergoes the watery fusion & spontaneous calcination, & when calcined it weighs only half the weight it did formerly therefore as it is not altered in its properties by this process, one ounce of it will produce similar effects, as two would have done in its crystalline form. It is not found ready formed in nature altho' it is thought to be so by the French, but this salt which they take for it, & in this in this country is daily vended for it, is formed by the union of the Δ wth a species of earth called magnesia, & the proper name of this salt is Sal Epsom being contained in the water of certain springs, & also in sea water. As this salt ^{by some thought} is far inferior in its medicinal qualities to Glauber's salt, there is a very simple experiment by which you may detect any impo-
sition when you purchase them; there is no Δ which

will produce any visible alteration on a solution of Glaubers salt its basis being a true S , but the solution of Epsom salt grows instantly white & turbid, the magnesia being separated by the S falls to the bottom of the vessel in the form of a white powder. These salts may also be distinguished by the eye, but this is not so accurate. As Glaubers salt is not found ready formed by nature, it may be made by adding the O to the fossil S , or to common salt, as directed by the Edinburgh dispensatory & exposing the whole to heat in close vessels, the O distills & the Glaubers salt is left behind in the retort.

Vitriolated Tartary

This substance differs in appearance from Glaubers salt being more of a whitish cast & having its crystals differently shaped. It is more unfusible than any of the salts, indeed it was long thought by the older chemists, incapable of fusion; this perhaps was owing to their furnaces not being capable of raising a very strong degree of heat, for it melts very readily in our melting furnace. When thrown into the fire it decrepitates like sea salt, its crystals contain very little water, therefore it does not undergo the watery fusion, nor does it caline by exposure to the air.

In using this salt then, regard must be had to the quantity of Δ it contains: as one ounce of it contains near twice as much saline matter as two ounces of Glaubers salt, it therefore takes twice as much of the last to produce the same effect as half the quantity of vitriolated would have done. But this salt is not much used in medicine, as it is very insoluble in Δ 1 lbj of boiling water dissolving only one ounce of it whereas the same quantity of boiling water will dissolve at least four ounces of Glaubers salt; tho independent of solubility they produce similar effects on the human body. With regard to its origin.

It is found in the bodies of vegetables in small quantity. if we express their juice & set it in a cool place small crystals of this salt will form in it. This is owing to the soils always containing some Δ which uniting with the Δ of the vegetable forms this salt. & it is for this reason that we never obtain a pure Δ from any vegetable by burning except from Tartar which contains no Δ . We obtain this salt perfectly pure by adding to the ashes of burnt vegetables the Δ .

The next two salts Nitrum Cubicum & Nitrum are formed by the union of the Δ & the

Soluble & vegetable Rb. They differ principally in the shape of their crystals, but as the Nitrum or common nitre is best known we shall invert the order & consider it first.

Nitrum

This is the most important of all the salts: it seems to be wholly of modern invention & perfectly different from the Natron of the ancients. Thus we hear we them speak of their natron efflorescing with vinegar, but our nitre has no such property; they used theirs also for the purpose of washing, but we know of no deterusive quality our nitre possesses.

This salt deserves particular attention from the changes it has produced in civil society, particularly for having changed the whole method of carrying on war, as gun powder is principally composed of it the other materials being added to make it more easily fired.

It appears in the form of a semiopaque saline body of prismatic crystals having six sides equal, & it melts a little before it becomes red hot into a transparent fluid. It dissolves very easily in water, a quantity of it dissolving in six times its weight of cold water, but of all salts it

dissolves the most differently in hot & in cold water
 for four ounces of boiling water will dissolve ten of it
 in an open vessel that exposes a great surface
 to the air, but in a narrow mouthed vessel it will
 dissolve much more. Its crystals contain very
 little water. It does not even decrepitate, much
 less undergo the watry fusion or spontaneous calci-
 nation. The characteristic difference between this
 & all other salts is; that upon being exposed to
 heat & coming in contact with an inflammable
 body it produces some remarkable appearances
 & undergoes some change in its properties, parti-
 cularly as soon as they come in contact a hissing
 noise is produced. The inflammable body is agitated
 & tossed about, & a considerable degree of heat &
 light is produced, being much greater than ought
 to have arisen from the inflammable body alone.
 This is called the deflagration & sometimes the
 detonation of nitre with inflammable bodies:
 to produce this effect, one or both the substances
 must be made red hot. & it answers best when
 both are heated, & the stronger the heat the better.
 The light produced may be modified by the nature

of the inflammable body we use. if the inflammable
 matter be great or slightly combined with the prin-
 ciples of the body ~~with~~ it will produce the greater
 effect & vice versa. If the Δ le body be continued to be
 thrown in till the deflagration ceases, the δ of the \circ remains
 behind and the ϕ escapes during the conflagration com-
 bined wth the Δ in the form of nitrous air or gas. If
 I add to the \circ a compound body that is very Δ ble
 for example ∇ , then the deflagration goes on very rapid-
 ly, & the light produced is so intense as nearly to equal
 that of the meridian sun, so that it is painful to look at
 it. In this case the \circ escapes in the form of nitrous
 gas combined wth the Δ of the ∇ & the δ is left combined
 wth the ϕ of the ∇ in the form of a vitriolated Tartar.
 If too much ∇ is added to the nitre it will then
 have a sulphureous taste & the salt left behind
 will be a mixture of Vitriolated Tartar & ∇ , & as
 this was supposed to have different effects from the
 former it has been called Sal Polyphresius. They also
 prepare an impure species of Sal nitre by adding
 to it less ∇ than is sufficient to destroy its defla-
 grating power so that the residuum is a compound

of nitre & Vitriolated Tartar. They have also a practice of melting the nitre in a crucible & throwing it afterwards into cakes & this by the French is called Crystal Mineral. In all cases of deflagration the Δ remains either pure or mixed wth some principle of the inflammable body if it contained any wherewith it was capable of uniting ~~and~~ It was supposed that in this process the Δ was destroyed but the fact is it unites wth the Δ & escapes in the form of nitrous gas. If nitre when red hot comes in contact wth an inflammable body in vacuo, it is decomposed just in the same manner as it would have been in the open air. This is the only instance of an inflammable body consuming without air coming in contact with it. Tho' in this case indeed the deflagration is not just so violent. By the deflagrating quality of nitre we can discover when a body contains any of the Δ tho' the quantity be exceedingly minute.

The heat produced by O during its deflagration of inflammable substances is very great so as to melt the most unfusible metals, & yet if this be done in a wooden vessel the deflagration goes on so rapidly & the vessel transmits so very slowly that it is not burnt. Thus we may melt O in a walnut shell. Here then I take a piece of O wire (a metal the most difficult to melt of any except O & Z) & lay it betwixt two strata of a composition of three parts of sal nitre one of A & one of saw dust in fine powder, & inflame the whole with a red hot iron, the wire melts into a round button while the shell is only slightly scorched.

In consequence of the deflagrating quality of nitre it is the basis of all exploded compositions the principle of which is gun powder of which I shall relate to you preparations. The two inflammable bodies made use of to promote the deflagration of nitre are charcoal of wood & Sulphur. These have been added in various proportions at different times & in different countries. I shall

mention the only proportion that can be depended on viz that by w^t the powder is prepared for the use of government, $\frac{3}{4}$ of the weight of which is Sal Nitre the other fourth part is equal parts of charcoal & of 4. But tho^t we use these proportions exactly the gun powder turns out differently according to the quality of the ingredients. In order to prepare it therefore as good as possible in the first place the Nitre must be ~~as~~ free of common salt ~~as possible~~ to effect w^t it may be dissolved in a given quantity of boiling water, upon cooling the Nitre forms into crystals, w^t are perfectly free of common salt as this last dissolves equally in hot & cold ∇ . The 4 is generally not adulterated w^t any foreign matter, but a great deal depends on the quality of the Charcoal, if it be made from some kinds of wood the kind for example it will not answer; that made from the wood of hazel bush or willow is the only kind that is used. All the three ingredients must then be reduced separately to a fine powder

and to produce this effect on the Salitre they dissolve it in as little water as possible, & then kept stirring over the fire till it is dry, and by this means minutely pulverized; the other two ingredients are reduced to this state by trituration. The ingredients are then put in proper proportion into a wooden mortar, the pestils of w^h are turned by a horse, & kept grinding till the whole is thoroughly & completely blended, a little water being now & then added to keep the finer particles from flying off, & to prevent heat from the friction. All this machines must necessarily be made of wood or of copper, for if they were to use iron part of it would be struck off by the friction & would set the whole on fire. The powder in this state when fired has very little effect & only burns like a train, not having enough of air between its particles to make all go off at once. They therefore add to it as much as is sufficient to make it into a paste; this paste is put into a sieve along with a wooden

ball, & the whole is by the rolling of the ball, broken
 down & made to pass thro' the sieve in the form
 of grains, or granulated as it is termed. It is
 then dried in a kiln ⁿ carefully, & afterwards sorted
 into different kinds by sieves of different fineness.
 In this state the angular particles of the grains
 do not touch in many points so that a sufficient
 quantity of air is ~~is~~ contained between them
 to set the whole on fire at once. The Powder is
 glazed by putting it into a wooden cylinder
 which is made to turn slowly round so that
 by rubbing on one another & on the sides of the
 cylinder they are polished in this very simple
 manner. They are then freed from the fine powder
 that is rubbed off by sifting. In this form we
 get it from Dantzick. The A given quantity
 of the elastic fluid of gun powder contained in
 a given space will exert a force ~~equal to~~ 244
 times greater than the same quantity of com-
 mon air, & this elastic force may be increased
 by heat, so as to exert a force equal to 1000

atmospheres: From this it is easy to account for
all the terrible effects of this composition. 19

Vitre is also the basis of some other explosive
compositions one of w^{ch} is the P^o Pulminans
w^{ch} composition has never been applied to any purpose
It contains three parts of Sal Nitro two of the
vegetable & and one of $\frac{1}{4}$ the Σ answers best
when saturated wth air and ought to have been
exposed to the air before home. When you throw
this composition into the fire it only crackles
but if instead of doing this you heat a little
of it slowly till once it melts & acquires a
reddish cast, then expose it suddenly to a strong
heat, it explodes wth a considerable noise, &
the noise is the louder in proportion to the quan-
tity of air the Σ contained. Tho' this sound
when we are near it is louder than the report
of a musket, y^t it is not heard at so great
a distance, the fact is there is not such a quantity
of air put in motion by the P. Pulminans but
it makes the quantity it affects sound very sharply.

No salt is more easily distinguished than nitre on account of its deflagrating quality. There remains only to mention how it may be decomposed, w^{ch} is effected by adding to it a proportion of O₂, the O₂ begins to separate immediately as is evident by the fumes, but a thorough decomposition does not take place till we apply heat w^{ch} raises the O₂ while the O₂ uniting wth the S is left behind in the form of a vitriolated tartar. This operation as it is the only one by w^{ch} we can get the O₂ is frequently performed in close vessels. It has been the custom to add to Lbⁱ of Sal Nitre ℥viii of O₂ & to raise the heat till the whole becomes dry, but I have found it answer better to add the O₂ in the proportion of ℥x to Lbⁱ of Sal Nitre. In the first place then the nitre must be carefully powdered, & introduced into the retort so as not the least particle may remain in ^{its} the neck: which is prevented by passing it thro a cylindrical roll of paper previously

introduced into the neck of the retort, & then the Oil is to be poured thro a crooked Funnel formerly described, otherwise if any of either the \times or of the nitre remain in the neck of the retort they will be carried over unchanged into the receiver by the first vapours that arises.

The Oil obtained by this process is as strong as it can be got, tho it is not always pure the nitre being commonly blended with a portion of common salt, which also is decomposed by the Oil & a species of *Agua Regia* rises from the mixture of the nitrous & marine acids. We must therefore if we want our nitrous acid perfectly pure, purify the nitre from every particle of sea salt.

In the large way of operating they commonly add 3xii of Oil to 3i of Nitre but as there is more than is necessary this Oil has commonly a mixture of Oil. From the residuum all the Nitriated Tartar used in medicine is prepared. They used formerly to obtain the Oil by adding Gold or Silver of Nitriol to the nitre but as this requires a great degree of heat, it is never now practised since the Oil can be got at so cheap a rate.

Nitre may also be decomposed for the sake of its Δ , as inflammable bodies change the O into a permanently elastic fluid that does not unite with Δ . Thus if we take seven parts of nitre & mix it with two parts of Charcoal dust, put the whole moistened with a little γ into a crucible & set fire to it with a red hot iron the O unites with the Δ & flies off leaving the γ of the nitre behind. Tartar may be used for this purpose instead of Charcoal, as it contains inflammable matter, & a fixed Δ so that by inflaming the two substances we get the Δ of both at the same time. When we use six parts of nitre to two of Tartar the residuum is of a white colour and is called the White flux. When two parts of Tartar to one of nitre is used the residuum is of a black colour & is called the Black flux which is very useful in some Chemical experiments particularly in assaying the Ores of Metals. In this case the deflagration is slow & the substances are fired with difficulty.

These are the methods of obtaining from this substance its α & x , & having thus got the ingredients of this salt separate by the processes I showed you if we again combine them they form a salt which crystallizes into prismatic crystals having all the properties of nitre.

Nitrum Cubicum

The description of this salt may be given in a few words. It differs from common nitre in the shape of its crystals; but the principal differences occur in its decomposition; if we deflagrate it with Φ a Glauber's salt remains behind, if we deflagrate with charcoal we get the fosphate δ . We ought not to use tartar to deflagrate it with otherwise the residuum will be a mixture of the fosphate & vegetable δ ; but if instead of tartar we mix some flour or mix some flour with it, after the deflagration we get it & immediately & perfectly pure. This salt is not produced in nature the only way of obtaining it is to mix together the

Or the fofpide &, but as it is not so easily got as common nitre it is not used for any purpose tho' their effects are exactly similar.

There now remains to consider the Natural history of Sal Nitre. Tho' there have been some minute proportions of it found ready formed in nature yet there are strong reasons to believe it is entirely an artificial substance. It is brought in considerable quantities from the East Indies, but by what method it is there got is uncertain. Dⁿ Boerhaave & Lemery say that it is in that part of the world swept from the sides of Hills & that the ground whereon it effloresces is remarkably cold & barren; but in this they have been certainly misinformed, as we meet with nothing analogous to this in any other part of the globe, besides as nitre is volatile it would be in danger of being evaporated from the violent heat of the sun or of being washed from the sides of the hills by the heavy rains. It may be made artificially in

in all parts of the world, but the process must be conducted in places inaccessible to the sun & rains. & it is probable that it is prepared in the East Indies the same way as it is done here, & from its being done in the interior parts of the country we can have no good account of it. In all cases where it is manufactured the *Ox* is the article that is produced & the nitre is formed by adding to it the *S* directly. The materials from which it is produced have the appearance of containing no *Ox*, being got from animal & Vegetable substances in a state of putrefaction such as old plaster, dung of animals, garden loam, &c. It has been proposed to add to these substances a small quantity of common salt, w^h would be of service towards regulating the putrefaction on which the success of the process depends; but it is found rather to be of disservice as it is apt to remain afterwards & to spoil the saltpetre. Wherever any of these materials are to be met with we are sure to meet with sal nitre, which, sometimes sinking into the ground, makes it appear as if really

formed in nature. This is probably the cause why we can obtain a little of it from the well in this town opposite the Gops. It may also be obtained where any vegetable substances have putrefied, as in the houses, walls exposed to putrid vapours, ~~see~~ stables, pigeon houses, &c, but in all these cases the quantity of nitre is far smaller than might have been got by a regular putrefaction.

Dr Crammer was the first who tried what substances yielded it best, & how much might be got from a given quantity of materials. He erected a low building, close on the top & on all sides except that towards the North, where there was a small door & some small windows. Into this building he placed a number of earthen pots filled with the materials, which he turned frequently that they might expose as great a surface to the air as possible, he also watered them frequently with urine. The substances he found answer the best were Old Rubish & garden mole, he found that these at the end of a month yield $\frac{1}{2}$ part of their weight

of nitre. It has been believed that N.E Winds con-
tain some nitrous particles as they are most fa-
vourable to the formation of nitre: but the true rea-
son is these winds are generally cold
& dry, & regulate the putrefaction by making it
go on more slowly. By this process it may be
obtained in any part of the world. In Sweden
they erect pyramids of mole &c, & water these fre-
quently with urine, and after a certain time the
materials yield $\frac{1}{8}$ their weight of nitre, & the re-
maining $\frac{7}{8}$ turn out good manure for their ground.
So that while they supply the state with nitre
they at the same prepare manure for their ground
Very similar to this the German petty princes
insist that their peasants surround their ground
with walls made of mole, dung, straw &c, &
walls as they are narrower at top than at the
bottom, allow the rain to run off without sinking
into them, & when driven down at the end of
three or four years afford a considerable quantity

of Nitre. In France the manufactory of Sal Nitre is a separate trade, the persons engaged in which have no fixed place of abode but wander up & down in search of places fit for their purpose. The places w^{ch} principally claim their attention being Pigeon houses, Old houses, Stables &c.

Besides these methods of making Saltpetre it may be obtained from certain plants, if we express their juice & set it in a cold place small crystals of Nitre will form in it; but it is to be observed that none but plants which have a bitter taste yield it, & they contain most when reared in cultivated ground, & never any almost when they grow wild, from hence we see that the sal Nitre is not generated in the plant but passes into them from the soil. No plant contains Nitre so often as Tobacco every body I suppose has observed that the stems of this plant continue to burn & fize after having

been removed from the fire like a piece of match pa-
 per. Some Tobacco that was allowed to rot in the
 American store houses produced a quantity of Sal
 Nitre w^{ch} I think was the purest species I ever saw
 of this salt, as all the ordinary kinds of Sal Nitre
 have commonly a mixture of common Salt. It
 is to be observed that much depends on the slow-
 ness of the putrefaction, & that it may come
 sufficiently in contact with the air, therefore
 often turning the materials is of great ser-
 vice. Wherever it is produced there is in all cases
 a second process: the first thing to be attended to
 is to form the Sal Nitre perfectly in the sub-
 stance & in the 2^d place to extract it per-
 fectly pure. My reason for mentioning the first
 is that the O^r instead of being joined wth
 a S, is combined sometimes with a quantity of
 lime & S, & it therefore becomes necessary to
 the formation of Nitre, to add a quantity of

of δ . The method of operating then is the following; the materials from which the salitre is to be extracted are put into a number of barrels the bottoms of which are pierced wth a number of holes, & which are lined wth straw. then water is poured upon the materials adding at the same time the δ , ~~so that~~ the nitre is dissolved by the δ which passes thro the holes in the bottom of the barrel & is received below in a proper vessel; here it is let stand till it becomes clear. then the operation of crystallization is performed by w^{ch} they get the nitre of the first sort or rough nitre in which state it is brought from the East Indies. It is purified by dissolving it a second or third time in water & then crystallizing it. There have been various conjectures how the δ is produced. The best of these supposes it to be

obtained from the air: but this is merely hypo-
thetical as there are never any nitrous particles
ready formed in the atmosphere. The 2^d That
it is contained in the bodies of vegetables but
this is also hypothetical as all vegetables don't
yield it equally in every soil. The 3^d Opinion
supposes it to be the Ox combined wth the Δ & so
changed by that means into the form of the Ox .
This is a favourite theory of Stahl's who always
endeavoured to reduce things to the utmost sim-
-plicity. But indeed I cannot here agree with
him, for I think that there is as great a dif-
ference between the Ox & Ox as between O
& H . Indeed the academy of Berlin (who cer-
tainly ought to be spoken of with a great deal
of caution) gave their prize to a German
who endeavoured to support this theory, he
having moistened a calcareous stone wth Ox
& wine, at the end of a month obtained

from it a little nitre, but the same experiment would have succeeded better if the O_2 had not been added. But it is more easy to quarrel with theories than to propose any thing satisfactory ourselves. It may however be queried may not the O_2 be produced by a somewhat different modification of the particles from what they generally yield during the other species of fermentation? During the putrefactive fermentation there is always a great quantity of air & some is produced. Now I am inclined to think that the O_2 & air are very nearly related & perhaps the same but differing only in purity & what leads me to think that the air is the principle which yields the O_2 is that the O_2 can be converted into a permanently elastic fluid having all the properties of common air that is, that it supports animal & vegetable life & flame! Also in the generation of nitre

The materials require to be exposed to the air, by turning them frequently, & the more air that is admitted the more nitre will be formed.

This is the whole I have to say on ~~the~~ ~~Ox~~ & you easily perceive it to be one of the most important of all the Compound Salts. The salts next to be spoken of are those two formed by the union of the ~~Ox~~ with the fossil & Vegetable & Sal Communis & Sal Digestivus.

Sal Communis.

Is more remarkable for its natural history than its Chemical properties. When it is exposed to a degree of heat sufficient to make it red hot it melts into a very transparent fluid, & if it be heated above this it flies off in the form of vapour & does not return to its original form till it is considerably cooled. Thus in the manufactories where it is used for the glazing of earthen ware, the vapour of it is made to pass up thro' them & escaping at

the top of the vent, it hovers in the form of a cloud for a mile or two around the country. Of all the saline bodies witherls taken notice of it is the most volatile and it also attracts moisture from the air. The common salt used at our tables has a mixture of something that tends to make it more deliquescent, than when it is quite pure, & in both states it is equally soluble in hot & cold water. For if we saturate it with four times its weight of boiling water, not one particle will separate when it cools, hence the ordinary process of crystallization cannot be performed on it & the only way to is to continue the evaporation to dryness. Its crystals are of a cubical form and when hastily prepared are very small. During the evaporation, there is an earthy sediment deposited that adheres to the corner of the pan in w^h the evaporation is performed & which has frequently to be removed. This the workmen call pan scratch; it is entirely accidental & owing to the impurity of the sea water. It has been said y^t common salt gives over its x by mere exposure

to heat, but this is owing to the ordinary kind of Θ containing a portion of Epsom salt, & is the reason that it is more apt to deliquesce, & when it is exposed to heat the Θ of the Epsom salt decomposes a little of the Θ of the Common salt. That Common salt contains Epsom salt is evident for on dropping a little Δ into a solution of it the whole becomes immediately milky. I have mentioned the effect of the Δ on all the salts hitherto spoken of but on Θ it produces no effect, except that when we throw it into the fire it burns with a bluish flame.

You see from its place in the table it can be decomposed by either the Θ or Θ , but when we wish to obtain its ⁺pure we must use the first of these, for if we were to use the Θ it contains so much of the Δ , that by the heat, it would become elastic, & come over along with the Θ into the receiver. The Θ in its ordinary state does not contain enough of water to condense the fumes of the Θ , if we would wish to have it in

a manageable form, we must use the O diluted wth its weight of water. It has been recommended to dephlegmate the O but this is altogether superfluous, & is only undoing what we propose to effect by diluting the O . It has also been recommended to use instead of the O , Colcothar of O Tobacco pipe clay &c. but these are all very badly fitted for the purpose. Chemists have generally mistaken the proportion of O w^{ch} ought to be used & generally recommend $\text{Lb} \text{ i}$ of O to $\text{Lb} \text{ iiii}$ of common salt, but this is by far too small a proportion of +, for it is much better to add a little too much than to use too little. The proportion I use is $\text{Lb} \text{ xii}$ of O to $\text{Lb} \text{ xvi}$ of common salt, though I daresay I might add $\text{Lb} \text{ xiii}$ of O with great safety. It is very singular that tho^{ugh} the O has a stronger attraction for S than the O yet the latter requires a greater quantity of S to saturate it than the O does, for from the above mentioned quantity of O & O we obtain after

The distillation & Effluvia of good Glauber's salt

These are the principal processes for decomposing it for the sake of its $+$, but there is no direct method of decomposing it for the sake of its $-$ as there is no salt has a stronger attraction for its $+$ than its $-$, we are therefore obliged to have recourse to a round about process, viz to deflagrate it along with Cubic nitre when by that means we get the δ of both the salts. This salt is most used & longest known of any of the saline bodies, & remarkable for its almost universally agreeable taste. There is no nation almost whatever that does not use it: horses & other cattle having once tasted it will go a prodigious way to come at it again. We have instances of cattle in America that take an annual peregrination of 300 or 400 miles, only to have the pleasure of licking a quantity of this salt, which is produced by the evaporation of the sea water during the intense heat of the solar rays. But it

is not only agreeable to the palate but it tends al-
so to promote health, for the cattle accustomed
to use it become remarkably fat & sleek; it also
promotes digestion, & is used to cure our provi-
sions on account of its antiseptic qualities &
agreeable taste. For all these considerations it
is produced by nature in considerable quantity
all the other salts put together would not make
above a third part of its quantity. It is found
in three different forms 1st In the bowels
of the earth in ~~the form~~ great beds. This kind
of it is called Rock salt or sal gemme. The
2^d Is obtained from sea water w^h species is
called Sea salt & the 3^d Is got from the
water of certain springs & is called Spring
salt.

The Rock salt is found in the greatest
quantities at Cracow in Poland where it is
thought there is as much as will supply the
world for 1000 years. It is there in beds of

100 feet thick, & it is reported that there are several families below ground there who never saw the light of the sun. These people have in their mines all the conveniences of life as cattle; houses & churches cut ~~out~~ in the salt & with the light of their candles reflects a beautiful green colour, so that their dwellings resemble more the magical accounts in the Arabian nights Entertainments than any thing else. Besides in Poland it is found in many other parts of the globe. In Cheshire in England there are mines of it that have been wrought for longer than history can inform us. It is also contained in the water of the sea. In Siberia there are lakes the waters of which are perfectly saturated with it, so that during the strong heats of the Summer, the water evaporating a crust is formed on the surface that will

allow men & cattle to walk upon it. It is also
 got from the waters of the ocean but not in
 any considerable quantity, these waters ge-
 nerally containing a 30 part their weight
 of common salt. indeed the *Mediterraneum* con-
 tains about 16 part of common salt at
 Marseilles in France But in the Atlan-
 tic & Pacific Ocean it is contained in smal-
 ler quantity. Rock Salt is generally
 of a dark dull colour tho it is pretty
 pure. It seems to be the great source of
 all the rest that is found dissolved in the
 waters of the ocean & springs, being dissol-
 ved & carried down by rains, & it would
 seem to have been gradually accumulating
 in the waters from the beginning. Rock salt
 is purified commonly by dissolving it in water
 & clarifying the solution by adding to it a quan-
 tity of bullocks blood. upon exposing the whole
 to heat, the blood coagulates as soon as it is
 heated up to 156° of Fahrenheit's Thermometer

and forms a fine network throughout the solution which entangling all the impurities, carries them to the surface where they are skimmed off along with the blood, & by evaporating the solution to dryness the salt is got perfectly pure. The Poloneses use it without being purified, & it is generally said that this is the cause of a disease to which they are subject called on that account the plica Polonica which affects the head and particularly the hairs of the head, & perhaps more rather be owing to the nastiness of the people, than the impurity of their salt. The salt is obtained from the water of the ocean & of springs by evaporating to dryness, & in the warmer parts of this globe, it is prepared by spontaneous evaporation. The sea water is laded into shallow pits dug for the purpose, where it is evaporated in a longer or shorter time according to the warmth of the climate. The salt obtained this way is called Bay salt. In the Isle of May one of the Cape Du Verd islands a ships crew will prepare as much Bay salt as will loaden a vessel of 300 tons burden in a fortnight.

The same process ~~has~~^{is} also ~~been~~ performed in some of the islands of the mediterranean, & has likewise been attempted in this country but without success.

Another method of obtaining the salt is to boil the solution till it becomes dry. This is practised in Germany & there is a manufactory for it in this country by w^{ch} the most of the salt we use is supplied. In this way of operating the sea water during the Spring tides is let into a large reservoir called the Buckey, & by standing there it deposits its impurities, & if the weather be warm it undergoes some degree of spontaneous evaporation. From the buckey it is pumped into the pans where it is kept boiling till it is evaporated to dryness. In this case the operation is far too hastily conducted, & the salt produced is far inferior to bay salt for curing provisions. On the Saturday's night the workmen after filling the pans wth sea water, put a fire under them w^{ch} is made to burn very slowly so as just to keep the water simmering the whole of next day, so that on

Monday morning the salt is got in larger crystals
than that w^{ch} is prepared the ordinary way, & is of a
finer quality, & accordingly it is sold at double the
price by the name of Sunday Salt

These are the principal circumstances w^{ch} regard to
this salt I shall mention only further a method of
imitating sea water as it is a matter of utility
in many diseases. This may be done by adding to
2630 of Common water one pound of Common salt &
half an ounce of Epsom salt. With an ounce and
a quarter of Mixture of Paris for the Pan seratic

Salt Digestions

This salt has got its name from its being supposed
to help digestion, it has several other names as may
seen in the table all of which are ridiculous.

It agrees very much in its properties with com-
mon salt, its crystals like it are cubical & its taste
is nearly as agreeable to every one. It has however
some differences. It is not so brittle nor so easily
powdered as Θ is or indeed any other salt, it also

Dissolves differently in hot & in cold water. The dif-
 ferences are still more remarkable when we de-
 compose it. When we do this for the sake of its
 acid & for that purpose use the O we get a
 vitriolized tartar instead of a Glaubers salt as
 in the former case, & if we use the O we get
 a common Nitre. These are the principal ob-
 servations with regard to this salt, its effects on
 the human body are exactly similar to those
 of common salt, its other medicinal qualities
 are wholly imaginary. It is not found ready for-
 med in nature as might at first sight be ex-
 pected, as its α is only got by burning vegetable
 it is therefore produced by adding the O to the
 vegetable & or the ^{last to} Sal Ammoniac w^h is frequent-
 ly done in order to obtain from it, its δ . These
 are the principal remarks on the salts formed
 by the union of the fopile acids w^h the δ , should

now proceed to those formed by the vegetable acid.
 & 8^o. but I commonly consider those formed by
 the f. file & the 8 first. These are called
Ammoniacal Salts as the 8 enters into
 the composition of them all, the purest species
 of which is the *Sal ammoniacus Volatilis*. These
 salts have a striking resemblance to one another
 none of them endures a great degree of heat, yet
 they endure a stronger one than should be expected
 from the nature of their ingredients. They may
 be distinguished from all other salts, by adding
 to a solution of any of them a drop or two of an
 8, a decomposition follows & the smell of the 8
 is immediately perceivable. I now proceed to
 speak of them in this order.

Ammoniacus Viriolatus

This salt was first discovered by Glauber, & by

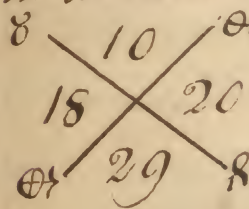
him imagined to possess some extraordinary medicinal qualities. It always preserves very great regularity in the form of its crystals which contain very little water, & therefore neither undergoes the watery fusion or the spontaneous calcination but they decrepitate very violently, even more so than common salt. It is the most fixed of all the ammoniacal salts, rising a little above a red heat and condensing again into a solid cake. As to its origin it is not found ready formed in nature but is only got by the union of its ingredients. It remains to consider its decomposition. This when for the sake of its α is easy as any δ has a stronger attraction for its \times than the δ has: but how it may be decomposed for the sake of its \times is a problem as no \times has a stronger attraction for its α than the O its basis. One might readily suppose that this might be adding by heating it in contact with charcoal dust, but in the present case this will not answer, because before the O can come in

contact with the Δ so as to unite with it the whole
 must be made red hot, or rather nearly approaching to
 a white heat so that the salt being volatile flies
 off leaving the charcoal in substance; & if we were
 to attempt combining them in a close vessel the e-
 lasticity of the vapour would burst it. I have men-
 tioned to you that the Θ when pure combines
 very readily with the Δ but when united with
 an α in form of a salt its attraction is by that
 means lessened. This salt may be decomposed for
 the sake of its α by first reducing to a Glaubers
 salt by the addition of the γ & δ then for-
 ming it into a hepatic Sulphuris by the addition
 of the Δ Or it may be done in the following man-
 ner. Mix with it equal its weight of any of the
 Compound Salts that do not contain the Θ
 as Θ or \odot , suppose it Θ , then expose the whole
 to heat a mutual exchange of ingredients will
 take place, the Θ will quit the δ & unite with
 the δ of the common salt. & form A Glaubers
 salt, while the Θ unites with the γ & forms a

Sal Ammoniac. This is an instance of Double E-
 lective attraction, w^{ch} At first sight is not so readily
 perceived, but may be explained on a very easy prin-
 ciple.

Suppose the four bodies acted upon like two levers
 A. B. moving on a common center. To bring the
 ends of these levers together it makes
 no odds whether the force be applied
 at one or both ends. The \odot is
 placed at the end of one of these
 levers and at its other end the \odot the \odot is placed
 & the \odot are placed at the two ends of the others. Now
 suppose the \odot attracts the \odot with a force as 30
 & that it attracts the \odot with a force less than
 that with w^{ch} it attracts the \odot , suppose 20. Sup-
 -pose the \odot attracts the \odot with a force as 20,
 & the \odot with one as 10. Now while these
 forces continue to counteract one another equally
 no decomposition will ensue. But upon exposing
 them to heat, as heat lessens the attraction of
 volatile bodies &c. just more than it does that

of fixt bodies for one another. Therefore while the attraction of the \odot for the δ is only lessened as one its attraction for the δ will be lessened as two, con-



sequently the forces no longer counter-acting one another equally, the two ends of the levers will be brought together & decomposition will ensue, the \odot lea-

ving the δ will combine with the δ & form Glaubers salt, & the \odot joining with the δ will form Sal Ammoniac. This instance is not an ideal one but one founded on practice, for upon this principle they proceed in the manufactory of Sal Ammoniac, & so prepare Glaubers salt at the same time.

The next of the Ammoniacal salts is the

Nitrous Ammoniac

The crystals of this salt resemble those of prismatic nitre. It is the most fusible of all the Compound Salts melting into a turbid liquor a little above of 212 of Fahrenheit's scale & it expands

seemingly as it passes from a fluid to a solid state
 It is very Volatile flying off in form of vapour if the
 heat is a little increased. It is very soluble in ∇
 producing cold during its solution, & its crystals de-
 liquate in a moist air. It may be distinguished
 from all other salts by its deflagrating when thrown
 into a red hot crucible without any addition. This
 seems to be owing to some Δ in the $\&$ contains as
 a constituent part, as any of the ammoniacal salts
 or even the $\&$ itself (deflagrate along with nitre)
 in the manner that inflammable bodies do.
 It can easily be decomposed for the sake of its
 $\&$ by any $\&$, or for its \times , by adding to it half
 its weight of \oplus & exposing the whole to heat
 in a retort with a receiver luted on. It is formed
 by the union of its ingredients & is sometimes
 produced in the process for making \circ , the $\&$ pro-
 duced during the putrefaction uniting with the
 \oplus hence in order to form the nitre it becomes
 necessary to add to the ley a quantity of vegetable

2. This salt is not used in Medicine or in the arts, tho perhaps it might ~~perhaps~~ be employed wth advantage in the first of these, but there has not yet been a sufficient number of experiments made to ascertain its medicinal qualities.

Sal Ammoniac

Is the most useful of all the Ammoniacal salts, & is applied to a great many purposes. It is one of those bodies that has its degree of volatility before its melting point, but it might be melted by increasing the pressure on its surface. It dissolves very readily in water having a strong attraction for it & produces a greater degree of cold during its solution than any saline body. I have frequently mixing it with ∇ both at the temperature of 50 ^{the 3rd in thermometer} made it fall 12th below the freezing point. Hence it would answer better than Glauber's salt to shew that experiment w^{ch} demonstrates the different effects of heat upon bodies in a solid &

this state, but it does not succeed so certainly as it does with Glauber's salt.

It is used in the arts & in very great quantity particularly in all of them where tin is used, in making of white iron, in tinning the insides of copper vessels, & it is often used in medicine. It was formerly all prepared in Egypt, & till within these 20 years it was not perfectly known how it was done. The Egyptians prepared it from ^{the soot of} their fuel, for w^o on account of the scarcity of wood in that country they use the dung of animals, & it is now prepared in this country by a similar process, exceeding by pure, & without using the soot obtained from the dung of animals. A ~~man~~ manufactory of this kind is carried on at Edinburgh; the method however in w^h they proceed is not known, but as they use a prodigious quantity of soot, particularly they have all the soot

of that town collected for them, I believe that from
 this rock they obtain the S & not the Sal ammoni-
 ac directly; & that they saturate this S with O₂
 & so convert it into a Nitric Sal ammoniac, that
 then they add to this equal its weight of common
 salt, & by exposing the whole to heat they obtain
 by a double elective attraction the Sal ammoniac
 & at the same time as much Glaubers salt
 [See page 49] & I am the more convinced of this
 as they prepare in the Manufactory at Edin-
 burgh ^{both} Sal ammoniac & Glaubers salt. ~~at the~~

Sal ammoniac may be decomposed for
 its S by either the O₂ or O₂. It may also be
 decomposed for its S by adding to it any S &
 exposing them to heat in a retort with a receiver
 luted on, & exposing it to heat, the S will rise
 in a solid form & line the whole inside of
 the receiver, & if the distillation is continued till just

as much water comes over as will (dissolve) the salt then the solution is called the Spirit of Sal Ammoniac, & if we remove the receiver & continue the heat till the whole of the water is forced off, there will remain in the retort a sal digestivus. The most extraordinary circumstance in this process is that the salt got in this manner is nearly equal in quantity to the sal Ammoniac from which it was got. This is owing to a quantity of aerial matter entering into its composition & not as Mr Macquer. supposes, to Sal Ammoniac's rising in substance having its properties altered.

I have now finished the Compound Salts formed by the union of the 8 & 8 fofible \times . It remains to mention those formed by the union of the different \times with the Vegetable \times .

These Salts are all of them destroyed by a red heat that is to say have their \times destroyed.

The Compound of the fofible 8 & 8 \times has not been distinguished by any name. With the vegetable 8 the \times forms a salt distinguished by the name of

Tartarus Regeneratus

This salt is very fusible, melting at the 620 degree of Fahrenheit's scale into a transparent fluid, & upon cooling concretes into a lacy like substance having its plates laid upon another very like to spermaceti & it is for this reason called Terra Solidata Tartari, its name is perfectly absurd. I do not even like the name of Tartarus Regeneratus, but as it has been long known by that name it is needless to change it. It has a greater attraction for water than any of the Compound salts as yet mentioned, 3i of water being sufficient to dissolve ℥iii of the salt, hence it cannot be got in a dry form but by evaporating the solution to dryness. It also dissolves equally in spirit of wine & water, & during its solution in water it produces heat. It may be decomposed by any of the foregoing &c. By adding to it green \oplus , & distilling in close vessels we get the \oplus in a solid form. This salt is always prepared by art & to obtain it pure we must add the \oplus to the purest kind of & viz Salt of Tartar. Though the \oplus be very pure the salt is always

of a dark colour, but it may be purified by keeping it melted over the fire till upon dropping into it some ∇ , it parts with its chariably matter which falls to the bottom, we may then render it perfectly pure by dissolving & crystallizing it. During this operation we must be particularly on our guard lest we heat it overmuch, & by that means destroy its acid.

In making this salt there is a circumstance which ought to be attended to, & the cause of it we will afterwards explain when we come to speak of the earthy bodies. When we add the \ddagger to the $\&$ we are apt to think it is saturated long before ^{the} ~~any~~ saturation happens, for upon pouring on the $\&$ no saturation will be perceived till the saturation is pretty far advanced & a good deal of the \ddagger added. In this case we are to take great care to leave off adding the \ddagger too soon for it is better to add a little redundant acid than that the $\&$ should prevail. The \ddagger we use may be that which remains after the distillation of

vinegar, as it is very strong, and the salt thus prepared may be purified just as easily as tho' we had used distilled vinegar. The effects of this salt on the human body are nearly similar to those of a composition called The Saline Mixture which is made by saturating the juice of lemons with salt of tartar. The proportions in which they should be added cannot be exactly ascertained as lemons are not equally sour but generally $\frac{3}{4}$ of Lemon juice will saturate $\frac{1}{2}$ of Salt of Tartar. This mixed with three ounces of Δ is of service to promote perspiration & prevent nausea. It is always prepared the moment wanted. The Salt formed by the union of the Δ of oxide, & Tartarous acid is called

Sal Rupellensis or
Sal Rochelle also Sal Signelle from an

apothecary called Signette at Rochelle in France
 who first prepared it. It was in great reputa-
 tion in France & has lately come a good deal
 into esteem in this country being a very ele-
 gant salt. It cannot be made to melt before it
 is made red hot, & by that means its acid decomp-
 -ed: it crystallizes very easily. As the Tartarous
 acid contains in its composition a proportion
 of vegetable & ~~fossil~~ it therefore is not a per-
 fectly neutral salt, but a compound of the
 Tartarous acid vegetable & ~~fossil~~. It is
 liable to the spontaneous calcination.

Tartarus Tartarizatus
 Differs in very few respects from the former
 except in its being a deliquescent salt, on ac-
 count it is also called Tartarum Solubile.
 It is obtained by adding to the vegetable &
 three times its weight of crystals of tartar

which is rather more than is necessary but since the crystals of Tartar, are very difficultly soluble in water, & when dissolved therein concret into crystals upon the cooling of the liquor, & if we employ any more of them than is sufficient to saturate the α , the superfluous part will crystallize, and we have nothing to do but to pour off the solution of the Soluble Tartar & proceed to crystallize it by evaporating it to dryness.

These two last salts may be decomposed by any of the preceding acids, hence it will be improper to give them to any person who has got an acid in the stomach, it would infallibly decompose it. This however is but little attended to & in consequence of their better taste, it is not uncommon to add to them some juice of lemons or Decoction of Tamarinds & even a little Ox , in order to make them more palatable, but by this method they are always decomposed & their purgative quality spoiled. There is only one ammoniacal

salt formed by the vegetable & & 8, the Vegetable acid that is its basis is the \ddagger .

Spiritus Mindereri

It is so called from its being always in a fluid form. If we were to give it a proper Chemical name it ought to be called vegetable ammoniac. It is prepared by saturating Distilled \ddagger with the & & is commonly made up the moment it is wanted. It is the most volatile of all the Ammoniacal salts as might be expected from the nature of its ingredients. It evaporates wholly in a degree of heat less than that of boiling water. Hence it is the only compound salt that cannot be got in a dry form by evaporating in the ordinary way for if we attempt this it flies off, & leaves the ∇ by itself. However it may be got in a dry form by a double Elective attraction, accordingly if we add to Regenerated Tartar, any of the fossile Ammoniacal salts & expose them to heat in a

retort with a receiver luted on, a decomposition will ensue, the vegetable ammoniac will rise in a solid form and the salt that remains will be a sal Digestivus a nitro or a vitriolated tartar, according as we use one or other of the fopile ammoniacal salts.

The last set of Compound Salts are those formed by the the Sedative salt & the three alkalis but of these only one is known That formed by the Union of the Sedative salt & fopiled is called

BORAX

Or Tincal, it differs from all the other compound salts in having alkaline properties, none of them change the blue colour of violet, but it in a very coincident manner, tho' not so readily as L^{d} do, changes it to a green colour, the reason is because it is an extremely weak one. Borax contains ∇ in considerable quantity its crystals therefore undergo the watery fusion & ~~spontaneous calcination~~ & when melted concreted upon cooling into a transparent

substance like glass. It may be decomposed for its
 + by any the preceding +. The most proper for this
 purpose is the Ox as it forms wth the S a salt w^{ch}
 dissolves equally in hot & cold water, so that if the
 quantity of water we use be sufficient to dissolve
 it when hot, it will remain dissolved when it
 cools, & the sedahed salt w^{ch} is very difficultly solu-
 ble in ∇ falls to the bottom without any mixture
 of the common salt. Borax is employed by Dyers
 to stiffen their silk: w^{ch} they dip into a solution
 of it in ∇ to w^{ch} it imparts a glutinous quality.

It is employed in the fusion of metals, as makes
 their particles when small cohere together into a
 mass, this it effects by keeping their surfaces
 clean, and at the same time not corroding them
 hence it is universally used in soldering. It is
 brought from the East Indies having its crystals
 covered with a fatty matter, & in this state it
 is called Toncal. How it is there obtained is not
 known. I am inclined to believe it a native substance

Some have thought it is there produced by some animal, but this seems to be done on purpose by the Indians to prevent its losing any of its weight by spontaneous calcination to w^{ch} it is liable. In this state it is very impure but is purified by the Dutch, & sent over so to this country. There is now a manufactory for this in England. It is performed by dissolving it in lime water, then by filtering & crystallizing it we obtain it perfectly pure. Tincal contains rather more sedative salt than is sufficient to saturate the S, & it is probable that the refiners take this method to increase its weight as I am told they will give ^{one} 6 wt of refined Borax for the same quantity of Tincal.

After having now considered all of the compound salts I shall mention some objections that have been started to the principle on which I have all along proceeded. It has been a general principle all along that the O has a stronger attraction for L than any of the other x^e. But if you dissolve Nitricated

64 Tartar in a quantity of O made lukewarm and diluted with its weight of water, the vitrified tartar will be decomposed, & the O uniting with the S will form nitre.

But this takes place only in certain circumstances, & this is the principle on w^{ch} we proceed to explain this seeming objection. It is only when the O is weak & diluted with its weight of water, for tho' we dissolve it in the strong O no decomposition will follow. This shows that it is not the O that does it, but that it is effected by a double elective attraction the O being more strongly attracted by the S than the O , so it quits the S to unite with it while the O unites with the S , so that by employing a figure as formerly see page 48 the fact may be very clearly demonstrated.

Another Objection is that if you add the O to Sal niter or Cubic nitre in a retort and expose the whole to heat the O is decomposed & flying off leaves the O combined with the S : but then it will not succeed if the O be not very highly colored with the Δ , so that we see that this proceeds as in the former case by a double elective attraction the four substances being the O , S , O & Δ . These are the only two exceptions to the doctrine I have adopted which upon examination you see are easily dispelled.

I have now finished the first class of the objects of Chemistry the Salts; the bodies next to be considered are the earths, which if what I have said upon the salts be understood, will be very easy, if not, they will be extremely difficult.

EARTHS

The distinguishing marks of the Earths have generally been said to be = They're insolubility in water, uninflamability, extreme fixity, fusibility by heat, & upon being melted concreting upon cooling into a substance having no resemblance to the original. But there are many objections which may be brought against this definition. Their not being soluble in water is no distinguishing mark, as every substance which does not dissolve in water is not an earth, nor is this strictly true for there are earths that are in some degree soluble in water. also they're concreting after being melted into a substance that has no resemblance to the original is not a proper

mark as many metals do the same, but these last always change into a substance whose weight to water is as 7 or more, to one. But earthy bodies ⁱⁿ never melt into a substance that is above $3\frac{1}{2}$ times denser than water. Earths may therefore be distinguished by these two properties: Their extreme fixity, & after being melted concreting upon cooling into a ^{*}glass that is not above $3\frac{1}{2}$ times denser than water. Hence we may learn to distinguish them by habit. The least attention to the earthy bodies will convince any one that they are extremely numerous, hence in a course of Chemistry of which they are only considered as a part they cannot be so minutely treated of, as this belongs more properly to the natural historian, but when we treat of them Chemically, all their properties with regard to heat and mixture shall be considered. One of the greatest difficulties is to arrange them properly. When regard is only had to their

* By the term glass I mean every body that is in some degree transparent, & breaks wth a polished surface.

external form, we are apt to consider the same earth five or six times or even a dozen of times as they appear under such a variety of different forms, & tho' this method of clasping has succeeded with great success in treating of the history of plants & animals, yet no one has succeeded in treating of the mineral kingdom in this manner. Even Seneus who is the father of all arrangement, & who attempted a work of this kind, saw the impropriety of arranging them in this manner to be so great, that he omitted publishing a second edition of his treatise on this subject. In this work of his they were arranged according to their external form, & as the crystals of alum & the diamond are both of the same shape they were put under the same class, an instance which shews the absurdity of the method, as there are not two substances in nature that differ more from one another except in their shapes. I shall therefore have recourse to Chemical properties, & in this mode of clasping I am not singular, tho' the only one besides who has done it is Cronstadt a Swedish nobleman who in an essay on the mineral kingdom

has arranged them not as they appear to the eye but according to their different qualities. Since his time there have been many discoveries, by taking in of which the whole may be made more simple but I shall follow his method except where new experiments have informed us better. Observe here I am not going to ~~give~~ consider the arrangement of the Mineral Kingdom, but of the earths only which form a part of it.

By the term earth is commonly meant that crumbly substance on the surface of the ground on which vegetables grow; but by the term earth I mean every substance that is exceedingly fixed, & that upon being melted concretes into a glass whose weight to water is not more than as $3\frac{1}{2}$ to one, & under this head I consider these four classes of natural historians viz Earth sand, Stone & Rocks. They form a very great part of this earth of ours, & indeed they seem to form the greatest part of it as far as comes under our considerations. We know very little

of this earth, there ^{are} indeed upon its surface some deviations from a sphere, but these are very small when compared to the globe itself; the highest mountain of the Alps is about two miles and $\frac{1}{4}$ high. The largest mountains in the world viz those ~~at~~ ^{of} Quito in South America are about three miles in perpendicular height, but it has been observed that the projection of these mountains does not hurt the figure of this earth more than the particles of dust hurt that of a common spherical globe. The surface of the earth is much rarer than the internal parts are, thus it was found by experiment last Summer that the mountain Schilhallem in Orkshire was twice as rare as the earth at an average, by its not attracting the plumb line so strongly as it ought to have done in proportion to its size if it had been as dense as the earth. This perhaps is owing to the external surface being free from that pressure to which the internal parts

are subject. All the knowledge we have of its internal structure is derived from observations made in mines & pits dug into it. The deepest of which are not above 2000 feet, in consequence of which however we find that it is not a confused mass as on the surface, but that the earthy bodies are regularly laid in beds, which are distinguished by the name of strata, & which are more or less inclined to the horizon in different countries according as they are hilly or plain. We sometimes find that these strata are driven as it would seem out of their natural position, probably owing to some convulsion this earth has at some time or other undergone.

These strata are sometimes broke across, and another kind of earthy matter poured in between the crack, this gives much trouble to the miners, & an appearance of this kind is by them distinguished by the name of Dykes; when they come to them they have just to dig thro' them & then they find the continuation of the strata in the former direction. There is another appearance which frequently occurs when the

71

strata appear to be driven out of their natural situation, & are either raised or depressed; this is called Troubles by the miners, which is a term that is very expressive of it occasions very great difficulty to find the direction of the strata. There is besides another appearance, when the strata are split in the direction of their length, & their interstices filled with a substance perfectly different from that of the strata themselves; these are denominated Vans and it is in them that all the metals are found except Iron which is often found in great beds. It is necessary to explain these terms as they often occur in giving an account of the earthy bodies.

Different names have been given to the strata according to their direction, but which I am not well pleased; they have been called primitive & secondary strata the meaning of which is, the primitive are supposed to have remained in their present condition since the formation of the world, & the secondary strata are supposed to have been removed out of their former direction, by some convulsion probably this earth has some time or other sustained. In the primitive strata there is very little variety & they are very little inclined. For example let us

Take a hill that is familiar to us, Ben Lomond, its strata are primitive, it is sloping on the one side & perpendicular on the other; there are other hills within two or three miles of the town, when we examine them we find that none of their strata are inclined above an angle of 15 degrees to the horizon, & we frequently meet with the remains of animal & vegetable substances in their bowels. The strata are always very regular & run commonly in the direction of an island, & what is very remarkable is that in the old world they run in the direction from East to West, & in the new world they run in the direction from South to North. Various hypotheses have been contrived to account for the regularity of arrangement in this earth, but none of them are unliable to objection. The chief of them is one of Buffon's who thinks that at the beginning all the strata were parallel, & that they were altered in their position by the agitation of the & with which this earth was covered. The chief argument he brings to support his opinion is the resemblance which a valley between two mountains has to the course of a river. But I think this cannot be demonstrated

unless he can show that all the strata were parallel at
 the beginning, & that the tides under the bottom of
 the sea unequal; but the chief argument against
 him is that if it had been owing to the action of
 water, the different particles would have lain in the
 order of their specific gravity, so that the largest &
 heaviest would have been downmost, & the smaller
 particles of these would have descended together so that
 the whole would have been a confused mass, but this
 we find not to be the case. Probably there have
 been remarkable changes produced in it by volcanoes
 as we have instances of considerable hills having
 started up in the space of forty eight hours, hence
 there is very strong suspicion that many of these
 changes have been produced by volcanoes.

Having spoken these few observations on the earths
 in general I now proceed to treat of them more
 particularly. All earths presented to us by na-
 ture are either simple or compound. By simple
 earths I mean those that appear so in all our
 Chemical experiments; the compound are those
 that may be separated into parts that are
 more simple. The simple earths have been

generally divided into four classes viz the Absorbent the Silicious, the Garnet & the Zeolite earths the two last of which I would willingly throw out of the class of simple earths, as I am almost perfectly convinced that they are not simple, if I knew properly where to place them. The marks w^{ch} distinguish these earths. are The absorbent earths effervesce with and dissolve in acids; the silicious earths strike fire wth steel & do not dissolve in acids. the garnet earth melts into a black glass without addition, & the Zeolite earth dissolves in the O^r but does not effervesce with it.

Thus the method of examining these earths on Chemical principles turns out exceedingly easy but in the subdivision of these classes we will have recourse to some other marks and shall use the original ones of the Natural Historians.

Thus the Absorbent earths are Chemically divided into three kinds viz the Calcareous, Magnesian, & the earth of alum, & these again subdivided by the marks of the Natural Historians, according as they differ in consistence, figure & texture & Colour.

Consistence as whether they are powdery or friable
 Texture whether they are in fibres or grains. Figure
 whether in form of crystals, & Colour whether it be
 green, red, or blue. I shall then consider them as
 combined with acids, then with other earths.

Absorbent Earths

The Characteristic mark of these is their dissolving
 with effervescence in acids & forming with them com-
 pounds similar to those of K & L . They are divided
 into three kinds The Calcareous which burns into
 quicklime becoming acrimonious, Magnesia which
 does not burn into lime & the earth of alum which
 does not burn into lime, & forms with the O
 a salt not perfectly neutral having a sour taste.

The

Calcareous Earth

Is very rarely met with except in strata that
 are ^{not} inclined above an angle of $9^{\circ} 20'$ to the horizon.
 It is sometimes found in a powdery form in the
 bottom of lakes being washed down from calcareous
 rocks by the action of the rain & in this state it
 is called *Agaricus Mineralis*. 2^{dly} it is found

in a concreted form of different degrees of hardness & texture two or three feet below the surface of the ground in England, but in Scotland there is hardly any. In this state it is known by the name of chalk, & is commonly found in lumps, with a piece of gun flint in the middle of each which led the Chemists to imagine that these two were originally the same. The 3^d form in which it is found is in that of indurated masses which are called lime stone, or *lapis calcareus*. Under this head I consider every stone or substance which burns into lime whether it be limestone or marble which two differ only in colour consistence & beauty, the last not being so apt to crack on exposure to the weather. Sometimes we meet with it in the form of transparent crystals with cracks running along it at right angles, by which means when it is struck it always breaks into rhomboidal crystals, in this state it is found in the veins of quarries the whin rock at the head of the town contains some of it, and it is distinguished by the name of Iceland crystal, and was a stumbling block

77

to Sir Isaac Newton, for it puzzled him to account for
a property it had of making a line when looked at
thro' it appear double, & both of them equally dark.
We sometimes meet with it hanging from the tops
of caverns separated from the water which drops
from their roofs & is called *Lapis Stalactites* or drop
stone, which when cut thro' transversely its inside
appears like ramifications of trees, & is on that
account sometimes called *Pandrial Marble*.

The ∇ from which it is separated contains only
a minute proportion of it dissolved in it, some of
the wells in this country have this petrifying pro-
perty, one in the wood of Hamilton & another at
woods do; But the most remarkable water of this
kind is a lake at Italy which petrifies every
channel that is dug to convey its water, & there
is a manufactory instituted upon its banks for
making statues which is effected by letting the
water run into moulds where it petrifies & leaves
the statue. To the class of calcareous earths
belong the shells of all the crustaceous animals

also pearls which are owing entirely to a disease in the fish, likewise the nests of little insects found in the bottom of the sea &c. We sometimes meet with these shells glued together by a calcareous matter of a black colour which when polished has the appearance of a beautiful variegated marble. In like manner we sometimes find the bones of animals glued together, & it is in this manner the greatest part of the rock at Gibraltar is formed. The term Marble which has been given to all these species of calcareous bodies is too inaccurate as it properly signifies only those kinds of it which tend to render the soil fertile now many of the Marbles so called do not do this, but the true ones may be easily distinguished by the following experiment. Take the Stone you would examine, reduce it to powder & pour upon it as much water as will wet it thoroughly, then add some Oil and if it be a Marble properly so called an efflorescence

will ensue; but many have got this name that
do not effervesce. If we do not make the experi-
ment accurately we may be mistaken, if we pour the
or on the stone without previously moistening it, &
as the effervescence depends on the separation of air
from the marble, as much air may be contained be-
twixt its particles, when we do not moisten it as
to make appear to effervesce as if it contained air
when it only contains it betwixt its particles.

We sometimes meet with it retaining its properties
when mixed wth the Δ , & on that account these
specimens of it have always a disagreeable smell
when struck with a hammer; these are always
of a black colour which sometimes is occasioned
by a mixture of metallic matter, but often to
the Δ , & upon burning they turn white by the dis-
ipation of the Δ . I shall now consider
the effects of mixture on the $\square C$ as it is dug out
of the ground; then the effects of heat on it which
are considerable; & last of all the effects of

mixture on it after it has been exposed to heat.
 If you add the Ox to chalk an effervescence will
 ensue which will stop without the Chalks being
 much diminished in its bulk, but may be renew-
 ed by breaking it down with a glass rod, the crust
 which forms on its surface hindering the farther
 action of the + upon it, but when we add the
 chalk in powder the whole of it becomes sur-
 face so as to dissolve without stirring. It dissolves
 readily in the Ox Ox & + , & forms with them
 a salt that has great solubility in water, but
 when we add it to the Ox it unites with it with ef-
 fervescence but does not dissolve in it, forming w^t
 it a substance that has very little solubility in
 water called Gypsum, Plaster of Paris or Selenites
 of which Lb of V takes up about 8 or 10 grains
 & it is owing to all the wells about this contain-
 ing some^{of} it that their waters are hard that is
 curdle soap, owing to the + of the soap being
 decomposed by the Ox of the Gypsum.

White marble dissolves wholly in the O , but black
 marble does not, as a blackish matter remains w^h
 is inflammable & on which its colour depends. When
 we add the O to a solution of marble in the O
 a decomposition takes place & the O uniting with
 the marble falls to the bottom in the form of a gypsum.
 Now this decomposition shews two things: first
 that the O has a stronger attraction than the
 O , & 2^{dly} that it evidently is a gypsum which
 is prime & for this I add as much water as will
 fill the glass up no solution will follow. The
 only O we have no effect on the O are the
 phlogisticated O & Sedative Salt; the Tartarous
 & joins with it a salt insoluble in water.
 These are the principal effects of O upon it.
 O have no effect on it in ^{its} natural
 state, but precipitate it when combined wth
 as they have a stronger attraction. If I add
 the vegetable O to a solution of O in the O

The earth falls to the bottom in the form of a white powder, & the δ unites with the ϕ & forms a Sal Digestivus. If to a quantity of water containing a gypsium dissolved in it I add a δ a precipitation also follows; & there is not a well in this town but turns milky by this addition.

They have no effect on Compound salts in the common heat of the air, but if we add $\mathcal{L}ij$ of Chalk: to $\mathcal{L}ij$ of Sal ammoniac, then expose the whole to heat, the δ rises and quits the ϕ & unites with the Chalk: and this remains in the form of a soluble salt. This operation is frequently performed as the ϕ is obtained in very large quantity being equal to the quantity of Sal ammoniac used, owing to a quantity of aerial matter combining with it during the operation. The other compound salt in which it has any effect is Vitriolated Tartar, & this may appear wonderful yet it is a very easy.

decomposition, & probably was the method hinted at by Stahl when he said he could decompose this salt in the hollow of his hand. In order to effect this decomposition the Nitratated tartar must be dissolved in tepid ∇ & upon adding to it a quantity of $\square^{\circ}C$ dissolved in the Ot or Ot a decomposition follows & the whole becomes milky; on standing a little an earthy matter similar to the Senile or gypsum falls to the bottom, & a Nitre remains dissolved in the water. This is an instance of Double Electric Attraction the moment the materials come in contact. Thus far with regard to $\square^{\circ}C$ in their crude states.

$\square^{\circ}C$ When pure resist the utmost degree of heat without melting; but are found to be remarkably changed in their properties, they become brittle & cracked & upon examination are found to have lost from $\frac{1}{3}$ to $\frac{1}{2}$ half their weight. and from a mild to have become a very cor-

rosive substances; & whereas in its former state
 it had little or no attraction for water, it comes
 to attract it so strongly, & on uniting with it
 raises such a violent heat as often amounts to
 a red one so that vessels, w^{ch} were laden with
 Quicklime have been set on fire upon spring-
 ing a leak. In its dry state it is called
 Quicklime, & when as much ∇ is added to it
 as is sufficient to make it fall into powder
 it is then called Slaked Lime. The unburnt
 $\square C$ has no attraction for ∇ , but when it dis-
 solves is burnt it dissolves in it & gives it
 alkaline properties, that is, it gives it an
 alkaline taste, & the property of changing
 the blue colour of vegetable tinctures to a green
 & when added to a purple infusion it abolish-
 es the red & heightens the blue colour. When

The Δ is saturated with lime it is called lime
 water. Authors have generally disagreed about
 the proportion of lime the water dissolves. Some
 say that 2lb of lime will saturate 10 of Δ others
 say it will saturate 500. I have found by experi-
 ment that lime Δ contains a 900 part of lime
 that is 8 grains to 2lb of Δ . Having said these
 things with regard to its effects on Δ , we shall
 now consider the effects of chemical mixture upon
 it. When in this state a stronger attraction for
 α than when it is crude, but if it is properly burnt
 it unites with them without effervescence. In
 this state it combines with & dissolves in the Θ
 & Sedative Salt as it did not do before. If it is
 added to Sal Ammoniac, a decomposition immedi-
 ately follows & the smell of the δ is straightway
 perceived without requiring the assistance of heat
 as in its crude state. The calcareous earth when
 unburnt has no effect on α , but quicklime pro-
 duces remarkable changes on them. If it is added
 to a δ dissolved in water it ceases to be quicklime

becomes again crude and loses its attraction for Ψ ; but the δ . becomes more acid and deliquescent & so gains those properties which the lye loses, it also becomes more fusible, & instead of requiring a red heat to melt it as formerly, it melts a little above of 212 . The δ ne salt in this state when applied to the human body corrodes it in a similar manner as a red hot iron would do and in this state it is used medicinally by the name of *Causticum commune* or *lapio Infernalis*, for opening humours & eating down fungous flesh, & is attended with no inconvenience, except that its attraction for Ψ makes apt to spread farther than it should do. When we mix lime with the δ it produces on it similar effects, it renders it much more volatile, & from having a weak it acquires a strong attraction for Ψ , so as it is impossible to get it in a solid form, it likewise becomes exceedingly acrimonious, but from its volatility it is difficult to apply it.

When a *Caustic* & however is added to an Ψ

87

it forms with it a neutral salt nothing different from what it would have done had it been added in its ordinary state, and it unites with it without any effervescence. This a good deal surprised the Chemists, and puzzled them to account for it, till Dr Black hit upon a principle that explains not only this, but every other thing I have mentioned in the clearest manner. These are the principal differences between lime & the DC. When lime is exposed to the air, it attracts as much moisture from it as is sufficient to make it fall into powder, & in this state it was supposed to be the same as slaked lime, but upon examining it, it is found to be no more lime, but a calcareous powder which has no attraction for Δ . Also if lime water be exposed to the air a crust will gather on its surface which upon examination will be found to be a calcareous earth that will not dissolve in water, & if the exposure to the air be continued the whole of it will fall to the bottom leaving the Δ perfectly pure if it was so before the lime was dissolved in it. In this manner it has been proposed

to preserve ∇ in long & tedious voyages, the only inconvenience that attends it is that it requires a greater surface to be exposed to the air, than can easily be effected on shipboard. Slaked lime when mixed with a quantity of sand and allowed to dry acquires a considerable degree of hardness, hence it has been the universal practice to use it as a cement in building. It is necessary to add to it sand brick dust or hair, else when it is used by itself it loses its water and falls off; but if we use hair it must be covered with the lime, else the action of the air will rot it. With regard to the proportion of these we may use 5 ^{parts} of sand to 6 of lime, but this will vary according to the purity of the latter. This mortar becomes harder in proportion to its age, & in the remains of antique buildings it is so hard as to render it as difficult to tear it from the stones that are imbedded in it as if it were one continued mass of rock. It has been supposed that the ancients had some method of mixing their materials from

what is now practised, & that they made their mortar better; & this has induced the moderns to try some experiments, in order to ascertain what proportions of the ingredients may answer best. Accordingly Mon^r Saurio in an essay on this subject recommends the following proportion; of fine sand & powdered bricks each three parts, of slaked lime two parts, these to be mixed with a proper quantity of water, and when about to use it to add to it two parts of quick lime in fine powder & then to apply it immediately, which he adds will grow hard in a very short time. There are some inaccuracies in this account that he gives us, for he ought to have mentioned what kind of lime ought to be used as the proportion must vary according to its purity he also exaggerates a little where he says that it will grow hard very suddenly but this is not the case, however in two years time it acquires the hardness of the most antique buildings; it is indeed very useful & the Royal Academy of Sciences at Paris give it all credit, having used it in the building of their observatory, and in making an

obelisk at Rowen thirty feet high. The only inconvenience which they experienced in making it was the powdering of the quicklime w^h they performed in mortars, & most of the men employed were attacked with a spitting of blood, owing to some particles of the lime being taken into their lungs, but this might be easily obviated by slaking it first with water & then heating it red hot by which means we got it in fine powder.

Magnesia Alba

Is an earthy substance, w^h was not generally known till about twenty years ago when Dr Black published a paper concerning it in the Medical Essays. It may be obtained, but not in a pure state, from many stones; but it is got in greatest purity from the salt obtained from the bitternd of sea water, or from the springs of Epsom w^h is the spurious Glauber's salt formerly mentioned by the name of sal Epsom, consisting of the Ox united with the magnesia. It may also be obtained from the

mother of nitre, but it is got purest from Epsom salt
 & that by a very simple process. Take equal parts
 of Epsom salt & of ^{vegetable} O₂, dissolve them ~~apart~~ separate-
 ly, & clarify the solution either by filtration or wth
 whites of eggs. Upon adding the solution of O₂
 to that of the salt, the Magnesia will fall to
 the bottom in form of a white powder, while the
 O₂ & O₁ form a vitriolated tartar, from wth the
 Magnesia must be perfectly freed, by washing it
 several times wth boiling water till it is per-
 fectly free from taste. Magnesia has all the
 characters of the O₂ C but is distinguished from
 them by its not turning into lime, & uniting wth
 the O₁ forming a salt soluble in V, & by this
 means we can detect any imposition when we
 purchase it, by mixing of the earth suspected wth
 V, then to add to it a little O₁ & if it is pure mag-
 nesia the solution will be perfectly limpid. On
 mixing it with the O₂ & O₁ it forms compounds
 that are exceedingly deliquescent & wth can only
 be got in a solid form by evaporating to dryness
 It also forms wth the $\frac{1}{2}$ a salt which is purgative

When a quantity of magnesia is taken into the Stomach it proves purgative if it meets with an acid there, but when the stomach contains no & it produces no sensible effect, but all the other species of absorbent earths when they meet with an acid instead of loosening, bind the belly. When Magnesia is given with a view to purge it will be necessary if the stomach has no & lodged in it, to drink some & after it, tho' I do not know of any but a fermented one will do.

If magnesia is added to lime water the quicklime will fall to the bottom by attracting the fixed air of the magnesia, & the magnesia will fall along with it. Dr Black exposed it to heat in a retort & receiver, & found in the last nothing but a little Δ , & by depriving it of its air by continuing the heat it acquired no acrimony, & in the form of Magnesia *Pulvis* it is sometimes preferable for medicinal purposes as it occasions no efflorescence in the stomach when given in that form. After thus being burnt it unites

with acids without effervescence, but forms compounds similar to those it did formerly, & in this state it has no effect on lime ∇ . These circumstances shew that the air is the principle w^{ch} enables it to effervesce with \times , that by it it affects lime ∇ , & that this air is nothing different from that of the Calcareous earth.

There is one situation in which Magnesia is obtained tolerably pure naturally, viz from the ashes of burnt vegetables; they contain a d & a little Tartarus Vitriolatus, but the whole of them does not dissolve in ∇ ; that part of them which does not dissolve contains an earthy matter Magnesia which we get tolerably pure by repeatedly washing it in ∇ , but it is never so white as when got by the other methods it being next to impossible to consume all the inflammable part of the vegetable, but if you wash the ashes of the plant & add to them the O^{il} an^{ti}epsom salts is formed from which the magnesia may be precipitated perfectly pure.

It appears to be wholly derived from the vegetable kingdom, it is only obtained from mother of O when vegetables are employed in the process. How it is produced in the sea water seems not so clear if it be not from the sea plants, but how the plants get it whether they separate it from the soil is not so clearly demonstrated. It is as certainly the produce of the vegetable kingdom as the PO is of the animal kingdom all of which seems to have been produced from the bones of animals.

Earth of Alum

The name shews sufficiently from whence it is obtained. It is sometimes found in strata blended with other bodies, but in this state it is always impure. I shall first then give you the natural history of the salt itself, then the method of obtaining from it its O & lastly its properties.

Alum is distinguished from all other salts by its

rough austere Taste. It is found sometimes in the earth in the form of octahedral masses being of the same shape as the diamond. It is obtained from some substances that shew no appearance of it; these are rough stones that are dug out of the earth, and w^h sometimes are in the form of slates called on it account Alum slate. Most of the substances shew no appearance of it till they are exposed to the air, when the alum effloresces on their surface & is on that account called *Alumen plumosum* but sometimes other salts that effloresce are improperly called by the same name. The substances that yield it always consist of clay & $\frac{1}{2}$ & sometimes a little $\frac{1}{2}$; there is a brassy coloured substance in pit coal that is capable of yielding a small quantity of it. The $\frac{1}{2}$ may be separated by exposing the bodies to heat & taking advantage of its degree of volatility, & afterwards by exposing the stone to the sun & air the alum forms in them. Some stones that in their natural state do not produce alum, do it after being heated red hot & then exposed

to the air, very readily. During the formation of the alum the substances become so prodigiously hot as actually to take fire. The most remarkable of these stones of produce alum are found at the bottom of the hill Tolpha in Spain; it shows no appearance of alum till it is exposed to the air, when the alum forms in it in very great quantity, & is called alum de Roche, Rock or Rock alum, w^{ch} is always tinged redish from some O^x it contains. The water that falls on them from the heavens, or which is thrown on them to quench the flame is collected in pits & from it the alum is separated by crystallization. The way the alum is formed is very odd, the stone consists of alum earth & A, so that heat being to the weather the O^x quits the Δ and unites with the earth of the alum. & the heat is produced by the change of form & new union. When the V is collected the alum will sometimes not crystallize if there is a redundant quantity of acid, this may be dissipated by making it red hot, but as this

is tedious. The common way the workmen do is to add to the ley, a solution of S & then proceed to the crystallization; they also sometimes use putrid urine for this purpose which contains a S . You'll easily see the alum will be different according as we use one or other of these ways. In the 1st way it will be perfectly pure; in the 2^d it will have a mixture of *Tartarus vitriolatus*, & in the 3^d way it will have a mixture of *Nitriolis Ammoniac*. By this method we can obtain it perfectly from any stone capable of yielding it. Sometimes the stone contains too great a quantity of A & sometimes also, a considerable proportion of S , & on this account, so that by taking advantage of this, in Sweden they obtain A Alum & green vitriol from the same substance. They first get the A by exposing it to heat, then they dissolve it & obtain the crystals of the green O , & last of all they get the alum which does not crystallize till the redundant acid be dissipated by heat, or changed by the addition of *lime*. The most remarkable source of it in this.

country is in Bedfordshire, which has a little & mixed with its ore. As this salt has acid properties it is much used by dyers, without it they cannot dye any durable colour, but if it contains any & that hurts the colour greatly. It is also used by painters, & with them also it does not answer unless it is free of Tarsurus Nitriolatus, Nitriolis Ammoniac or & in all cases where they want to make a pure colour they use Rock Alum, but in many cases where it is not required so pure the English Alum will do very well. It is sometimes found in the earth in the form of octohedral masses like the native shape of the rough diamond, & on this account it has been classed along with it in the books of the Natural Historians. In this state it contains about half its weight of water of crystallization, so that it undergoes the watery fusion, & when freed of all its water by heat it is known by the Name of Alumen Istum, we conceive generally to be very different from what it was formerly, but it differs in nothing but in wanting its water. In this state it is

used by Surgeons to destroy fungus flesh. It acts
chiefly by attracting ~~water~~ moisture from the lips
of the wound and is apt to make them become
too hard. 99

Its earth ~~may~~ be obtained by adding a S. wt
throws it to the bottom, & we get it perfectly pure
by washing it several times with warm water.

The only difference we observe between it & the
Magnesia is that it forms with water a tougher
paste, & when united with the Ot forms Alum.

It unites with the Ot & Ot & forms with calx of
them a sour salt. Dr Black says so that it
does not effloresce with x^o , but in this he was mis-
taken, for it effloresces very evidently if too great
a portion of x has not been used to precipitate it
which attracts from it its air. It is distinguished
from \square by \square doing in the Ot. It has a weaker
attraction for acids than Magnesia has. From it
Dr Black expected a peculiar species of lime, but
tho' it lost a little of its weight on being burnt, yet
it acquired none of the properties of lime, and after
this it unites more slowly with acids than it did

before. The weight it loses on being burnt is according to the state it was in before hand, if no more L was used to precipitate it than was just sufficient, it loses on being burnt $\frac{1}{3}$ of its weight, but if too much L was used it loses scarce any. Before it is burnt it precipitates lime from lime V , but has no effect on it in its burnt state. These & a great many other phenomena puzzled for a long time the ingenuity of the Chemists, till about the year 1756 Dr Black hit on a principle that explains with the greatest clearness all the circumstances I have mentioned. This principle of his is the most valuable discovery hitherto made in Philosophy except those of Sir Isaac Newton in Optics. But as Dr Black's theory has been universally received I shall not trouble you with other hypotheses.

Of Fixed Air

The principles on which he grounded his theory are these. That as Magnesia in its burnt state

Of Fixed Air

contains no air, & does not disturb the transparency of lime water, as it does in its ordinary state when it contains air, therefore the lime becomes mild by attracting the air from the unburnt Magnesia. also when he made lime in a retort with a receiver luted on, tho' the DC became lighter yet nothing was found in the receiver but an elastic fluid, & a minute proportion of γ , therefore he concluded that it acquires the properties of lime by losing this air which it contained in a solid form. This he denominated fixed air in conformity to Dr Hales name who first gave to the air contained in plants. Sometimes it is known by other names, as that of Mephitic gas from its being supposed to have a bad smell. These were the principal facts that led Dr Black to this principle, but as he conceived it would meet with great opposition, he stated every objection, & subjected them to the trial of experiment. I shall now explain, now, I will

show you most of the experiments whereby he confirmed his doctrine.

His theory then is that all α ne salts and $\square C$ contain a quantity of air, by which means they are deprived of their activity; hence in this state they are impure bodies, & when deprived of this by fire they become perfectly pure, & shew all their properties. This doctrine is very plausible from analogy, for we see that corrosive substances when united form compounds perfectly, as α & α^2 . So the component parts of the $\square C$ when, viz. air & earth when in their separate state are very active, but when combined form a mild substance. The air they contain adheres to them with a considerable force & the \square & Magnesia require to be exposed to a considerable degree of red heat before it can be separated. Vitriol α & α^2 with a considerable force, & has not been attempted to be separated by fire; but I mentioned a process by w^{ch} it may be separated from them by lime, and by

This treatment the ϕ are rendered considerably ^{more} active, & the ϕ more volatile as well as active. We are then to consider them as compound bodies & in consequence milder than in their pure state. From this doctrine there follow several consequences, consequences which at first sight we are not disposed to admit. & we would need experiment to confirm them.

Suppose we admit that crude DC when burnt loses its acid, & that it undergoes the same change when united with an acid, it ought therefore to saturate the same quantity of ϕ in its burnt or unburnt state. Suppose One Takes ℥iii of white marble which we convert into lime, this is attended with a loss of weight: a given quantity of ^{pure} white marble will lose $\frac{1}{3}$ of its weight on being burnt. Therefore ℥ii of the lime should saturate as much ϕ as ℥iii of white marble. In trying this experiment care must be taken that the lime be properly burnt, and that we make it ourselves, otherwise the common quicklime will not do.

Dr Black took 100 grains of Chalk: which he exposed to the strongest heat of a smiths Forge for $\frac{1}{2}$ an hour & he found that it lost 43 grains of its weight; he also found that the 57 grains of lime would saturate as much \times as 100 grains of Chalk, & that during the union of the 100 grains of Chalk with the \times it lost the same quantity of air as it did on being burnt, till within a grain or so, owing to a little \times which the fire dissipated during the operation. That it loses its weight on uniting with om \times may be demonstrated by a very simple apparatus. Take a Florence flask & put into it a quantity of water together with 100 grains of white marble. Place this flask in the scale of a ballance, & in the same scale a little vial of the O , & put into the other ^{scale} as much matter as will keep the two scales in equilibrio, & in this state they would remain for ever, but on pouring the O out of the small vial into the Florence flask, & then placing the vial again into the

scale. He it will begin & act upon the marble, and during their union a permanently elastic fluid, nothing different from that obtained by burping, at the same time the scale containing the Florence flask will gradually rise, so as at length to require the addition of 40 or more grains to restore the equilibrium. On the other hand when we add Quicklime to an acid, it joins it without effervescence, & if we try it in a balance there will be no loss of weight if the lime has been properly burnt.

Another consequence of this doctrine I have mentioned, & which will require the proof of experiment is, That if lime is nothing but $\square C$ deprived of air, if when added to an acid salt it attracts its air, the α ought to lose its weight & the lime become again a $\square C$. That this is the case is clearly shown by experiment. Take 100 grains of white marble, upon calcining them they will be found to weigh 60 grains throw these into a solution of ζj of δ . The lime will fall to the bottom, & on collecting it carefully it will be found to weigh 100 grains, the δ will be found to have lost 40 grains of its weight, and as this answers infallibly it proves the doctrine sincere

A 3^d consequence of this doctrine is that if lime be nothing else but $\square C$ deprived of air, if part of that lime can be dissolved in ∇ , the whole ought to be capable of solution. This is a circumstance that was never thought of & Dr Black. has often told me, that he was more afraid of trying this experiment than any of the rest. He took 8 grains of lime which he shook with xxviii of Distilled ∇ , & he found that it all dissolved except $\frac{1}{24}$ part the $\frac{1}{3}$ of a grain, this upon examination he found to be one half of it a whitish matter that effervesced with the O , the other half was rust of iron, so as it was not a $\square C$ could not be burnt into quicklime, & the whitish matter was $\square C$ unburnt.

It is very wonderful that no more than $\frac{1}{24}$ was found to be insoluble as even distilled ∇ contains air, but this air seems not to be the kind that lime is disposed to attract, for if I put two bottles one of Lime ∇ and the other of ^{under the receiver of an air pump} common water, both of them will start with their air equally and the lime ∇ will retain its properties, I also can

keep lime & as long as I please in a bottle that is
 but slightly stopp'd, now if it were disposed to at-
 tract the air within the bottle, a vacuum would
 be formed, so that the external air rush in, & soon
 till the whole lime would be precipitated but this
 evidently is not the case. Fixed air then is differ-
 ent from common air, it seems to be similar to that
 produced from fermenting substances, for if this air
 be put into a bottle & shaken with lime & it pre-
 cipitates the lime in the form of a \square . There is
 a cave in Italy from the bottom of which an air
 like this exhales, & is call'd the Grotto Del Cani
 from its being destructive to dogs & other low
 animals, when they go into it, but man who stands
 upright is permitted to enter with impunity. The
 term Fixed air was given to it by Dr Black, but
 it has received other names as Sphritic gas
 which probably will be the vox signata for it.
 We find it sometimes contained in the mines
 where it is quickly known by its halting out the
 candles, & then if they do not immediately run
 away it bereaves them of their senses in a

moment. Hence it has been called the deadly damp.
 Fixed air is also similar to that which has contributed to the inflammation of inflammable bodies. That this is the case may be shewn by a very simple experiment. Put a quantity of chalc into a bottle and add to it some Spirit of Nitre, the two bodies immediately begin to act upon one another, the fixed air rises and fills the bottle, & if we put down into it a lighted wax Taper it immediately goes out; if we incline the bottle & at the same time hold its mouth near the flame of a candle, the fixed air being heavier than the external air runs out & immediately extinguishes the flame.
 For this experiment the Ox is preferable on account of its fixity so that no vapour rises from it, & because it forms with the chalc. a solid substance y^t is not apt to run out when we incline the bottle. Fixed air is not only similar to that which has contributed to the

inflammation of combustible bodies, but it is also similar to that which has been respired by animals, which can be proved by a very simple experiment.



I take a curved glass Tube, into which I pour a little lime water, it does not in the least effervesce with acids. When I apply one end of the tube to my mouth, & draw thro' it

the external air into my lungs, no change will be produced on the lime water, but if on the contrary I blow thro' it a quantity of air out of my lungs, the water will become milky & the lime will be precipitated, & upon examination it will now be found to effervesce violently with ϕ .

This aerial matter is the common air changed by the inflammation of combustible bodies, & the by the respiration of animals, & seems to differ from common air only by being charged with the Δ . As therefore fires are continually burning, & animals breathing, we would naturally be led to think that all the air in this globe would soon be changed in this manner; this very certainly

would have been the case, & this (earth long ago) would have been rendered uninhabitable; Had not nature prevented it by some contrary process. What this process is, is not known, But it hath long been my opinion that it is done by the growth of vegetables. Several experiments have been made to prove this, but one made by Dr Priestly was the only one that ever succeeded. He found that a vegetable grew in a quantity of this air, & afterwards was rendered fit for respiration & allowed combustible bodies to burn in it. But this experiment has never with any but Dr Priestly himself. I can easily conceive that a plant will not grow in a quantity of fixed air, but that it would do so in a mixture of equal parts of it & common air is probable. In what manner, nature does this operation is uncertain & concerning it there have been ~~two~~ opinions. 1st That the vegetable attracts the air in substance. 2^d That it only attracts from it the Δ , so that by this means it is resto.

red to its original purity, & of course becoming lighter as it occupies less space than formerly. It is not determined by clear experiment in w^t of these ways it is performed. I am disposed however to adopt the last of them, for if it were done in the first manner then there would be a quantity of air lost, so that I am rather disposed to think it happens by decomposition.

I have hitherto considered this elastic fluid given out during the union of \square^c with x as being homogeneous, but it contains some common air, for upon employing a quantity of it to disturb the transparency of line ∇ , it will be found that $\frac{1}{32}$ part has not this effect. It may be further observed that a small quantity of it is inflammable, owing to some δ from which the chalk is never free, forming with the x inflammable gas, but that obtained from white marble is perfectly uninflammable. This air being mixed with nitrous gas produces no effect on its colour as common air does in consequence

of attracting from it its Δ . In consequence of this Dr Priestly has proposed, in this method to examine the purity of air. This can easily be done by taking in our pocket a bottle full of water, & emptying it when it will fill with the air of the place, & we have nothing to do but to cork it accurately, & bring it home with us where we may examine its purity by mixing it with nitrous gas. Dr Priestly thought that this way of trying the purity of air would be universally acceptable, but by it we cannot discover the nature of the air got from putrefying bodies, nor can we discover those noxious steams that are the causes of the plague & other epidemic diseases.

We obtain the same air from a D.C. by exposing it to heat, as we do by uniting it with an x . At first the air in the receiver will be the same as common air, as the air contained in the retort is expanded & forced over by the heat, but if we allow this to escape, we

will find that the air which comes over meat
 extinguishes flame & kills animals, that it is
 heavier than common air, & disturbs the transpa-
 rency of lime water. It proves that it does not
 as has been imagined acquire these properties
 from the steam of the \times . It has been suppo-
 sed that Lye salts made caustic by lime contain
 some lime, but if the operation is properly per-
 formed they should contain none. Take two parts
 of quicklime & one of vegetable δ , put them on
 the fire in an earthen pot with water, take it
 off when it is pretty hott and after allowing
 it to stand for some time, pour off the clear
 solution, & if you want to get it in a solid
 form put it into a retort & boil off the \vee
 but if you were to carry this operation so far
 as to evaporate the whole \vee , the \times would become
 so excessively corrosive as to eat a hole in the
 bottom of the retort. You must therefore perform
 this last part of the operation in a golden.

or silver bowl, on which the α in its most corrosive state has no effect. In this state there is not the least particle of lime in the composition, for upon dissolving it in the Θ , no scum falls to the bottom; which is our sign, when so great a proportion of lime is added.

If I can separate a $\square C$ from an α so as it may not attract any fixed air, then the $\square C$ will be converted into lime without the assistance of fire.

Here I take a few drops of a solution of $\square C$ in the Θ , & I add to it a solution of a perfectly caustic δ , which decomposes it, & the lime thus formed dissolves in the ∇ . But if I use a solution of a mild δ the $\square C$ immediately falls to the bottom having none of the properties of lime. If we perform this operation on Magnesia it dissolves in α without effervescence as burnt Magnesia does.

It also follows that if I add a perfectly caustic δ to a quantity of lime ∇ , it will not disturb its transparency, if it is perfectly caustic, otherwise

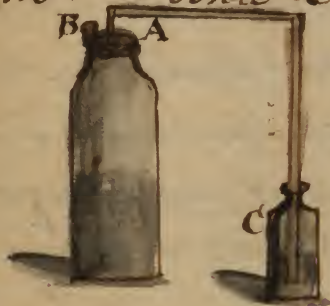
if it contains the least particle of fixed air the
 & will become milky, so that this may be considered
 as the most perfect test of a caustic.

The last circumstance I shall mention is that if
 quicklime on being exposed to the air attracts fixed
 air and regains the property of effereffing with
 x. Caustic ought to do the same. and this we
 find answers infallibly on being exposed for 24
 hours, when it crystallizes into regular crystals.

The same should also happen to the & but, it can-
 not be tryed else it would fly off in the form of incoer-
 -cible vapours.

I shall here shew me mix a
 caustic & with fixed air, whereby tho' before it would
 neither disturb the transparency of lime ∇ , nor effe-
 -rese with x. upon saturating it with the air it
 will do both in very great perfection; & this may
 be shewn by a very simple apparatus.

Into this bottle I put a quantity of chalk and
 along with it some ∇ . I then stop
 its mouth with a cork which is pier-
 -ced by the tube A and the little fun-
 -nel B. the other end of the tube A
 is put into a small vial C below the
 surface of a solution of & which half



fills the vial. I then pour a quantity of O thro the small capillary funnel B, which uniting with the chalk, separates the fixt air which arises thro the tube A and passes thro the solution of the caustic α , and after having done this for some time it fills the upper part of the vial C so that if I stop its mouth and shake it the air will be attracted by the α so that I will not be able to remove my finger easily on account of the pressure of the external air. This α will be found on trial to render lime water milky, & to effervesce violently with acids. It then follows that if we could separate α from γ without adding a third substance they would be in a caustic form, but we know no instance of an α passing with its γ on exposure to heat without addition except the Phosphoric acid, tho some persons would seem to insinuate this was the case. Thus in the decomposition of O by inflammable bodies, but in this case the δ gets air from the inflammable body. Another instance is in the decomposition of regenerated Tartar by heat but during the operation the acid is converted into air. From all these experiments it evidently follows that the D & attracts fixt air, more strongly than

& do, & the reason why we cannot separate all the air from α by heat, is that they rise in form of vapour a little above ^{bright} red heat.

I shall here explain a circumstance I formerly mentioned, and w^{ch} I referred to this place for explanation viz when we add the \ddagger to salt of tartar, no effervescence at first appears, the reason is that the δ is not fully saturated with air, and the acid unites with the most caustic part first, or if it should chance to unite with any that contains air, the air is immediately absorbed by the caustic part of the α so that no effervescence can be perceived till a great quantity of the acid is added. Now if you take δ that is perfectly saturated with air, the first quantity of the \ddagger that is added to it will effervesce, which shews the justness of this explanation.

α ^{ne} salts may be saturated with air by placing them above the steams of fermenting substances, or of burning charcoal, or by exposing them to heat along with animal or vegetable substances, as flour, sugar &c. & when they are perfectly saturated with air they will crystallize; this was thought to be owing to an acid contained in the air, but

Dr Black plainly shewed it to be owing to the absorption of fixt air. & ^{ne} Salts in this State contain about half their weight of air, hence it is necessary for those who trade in this way to know that, as that which contains the least air is the most valuable. The Σ which is got by burning Saltpar contains about 40 p^{cent} of air w^{ch} it is necessary to separate for the purpose of soap making. The goodness of the Pulvis fulminans depends on the quantity of air the Σ we use contains, if we were to use not ashes the powder would be good for nothing as it is the air mixing with the elastic matter of the nitre which produces the explosion. The quantity of Σ obtained by subliming it from a mixture of chalk and Sal ammoniac owing to the air contained in the chalk entering into the composition of the Σ , and increasing its bulk, & not as has been imagined to some of the chalk rising along with it. Mon^r Du Hammel exposed some Σ prepared in this manner to the air, & he found that a whitish matter remained w^{ch} was not volatile in the common heat of the air, this he took

to be Chalk, but upon examination it was found to
 a little of the & completely saturated with air, for upon
 adding to it the Oil it dissolved in it without forming a
 any Selenite. The salt & Spirit of Hartshorn have common-
 ly been thought the same but the salt contains a great
 deal more air than the spirit does. The one salt that is
 the chief in point of mildness is the spirit of Sal ammoniac
 but its mildness or causticity depends on the causticity of
 the one salt from which we distill it.

I shall here also explain a circumstance I formerly men-
 tioned to you viz if chalk is added to a solution of crys-
 talls of tartar it unites with it & forms a selenitish mat-
 ter which is insoluble in water. Now if you add lime
~~to~~ to a solution of soluble tartar, a decomposition
 takes place the & quits the tartarous & and remains dissol-
 ved in the water while the lime unites with the tartarous
 acid and falls to the bottom in the form of a tartareous se-
 lenite. Now this is a double Electric Attraction, there being
 four substances the ∇ , lime, &, & tartarous acid, the & ha-
 ving a stronger attraction for the ∇ quits the tartarous & is im-
 mediately attracted by the lime, & forms the tartareous se-
 lenite. The Oil Selenite has a little solubility in water
 for when we add the Oil to lime ∇ there is no precipitation
 but the tartareous Selenite has no solubility in it at all.
 If we were wanting to know the attraction of & for
 & we would place them in a column, & in the order of their

attractions when in their purest form. X S D C S

From all these experiments I have mentioned that the D C has a stronger attraction for fixed air than any other substance has, as lime is precipitated from its solution in V, on the addition of L or magnesia, by attracting from them their fixed air. Magnesia also has a stronger attraction for fixed air than the S has, for upon adding burnt Magnesia to a solution of E the L turns caustic.

This air has the property of mixing with water and communicates to it acid properties, enabling it to change the blue infusions of violets to red, &c. Mineral waters contain fixed air, which is probably communicated to them by the L of the F contained in the bowels of the earth uniting with the D C, separates that air known to the miners by the name of the deadly damp, which air gives these properties to the V we run thro' it. The V of Piermont contain fixed air dissolved in them but they also contain other substances whereas the waters of Selzer contain nothing but fixed air. The briskness of beer is owing to the fixed air it contains, and when it has become stale or dead as it is called, its briskness may be restored by driving fixed air thro' it. Another circumstance is that this V has the property of dissolving chalk, and as it dissolves the water loses its sour taste. By this we can account for the petrifying V

The petrifying well at Sarsborough contains near as much air as that of Permont does, and its chalk may be separated by taking from it its fixed air. Mineral waters contain commonly about their bulk of fixed air, but those of Permont contain only half that quantity. These waters disturb the transparency of lime ∇ , have a sour taste, dissolve chalk, & in this state have all the properties of petrifying waters. If a caustic alkali be added to a quantity of petrifying water the whole becomes immediately milky, & attracting the redundant fixed air by which the ∇ was enabled to dissolve the chalk, but this appearance is not produced by an α that is not caustic. Permont water contains besides fixed air a minute proportion of ϕ which may be imitated by adding to ∇ impregnated with fixed air a few grains of steel filings.

Thus I have finished the history of the absorbent earth. & have enlarged particularly on the DC, and its nature when changed by fire. Most of the experiments are Dⁿ Blacks, all the conclusions are haw of the experiments a few only are mine own.

I proceed therefore to the next class of bodies the

Silicious Earths

The properties of which you will find to be not so nu-

merous as those of the former, as their nature is not
 like them altered by fire. Silicious earths are more har-
 -dicular than any of those following, & may be distin-
 guished from every other by their extreme hardness, &
 alone is sufficient to distinguish them from every o-
 ther except some species that belong to the garnet class.
 In speaking of them then we mean the purest kind of
 them, these strike fire with steel, cut glass, & may
 be distinguished from the garnet by its fusibility.
 The Silicious earths in their pure state are unfusible
 they are found sometimes in the form of a slate, but
 more frequently in the form of regular crystals, hence
 they have been called crystalline earths. In consequence
 of their being employed in making that most va-
 -luable & beautiful substance glass they have also
 been called vitrescent earths, but this is absurd for
 they do not melt without addition. It is extremely
 difficult to divide them properly as we have nothing
 but colour & texture to go by, and it is on this account
 that they occupy the greatest part of many systems
 of mineralogy as they put on so many different ap-
 -pearances. I shall examine them under all the dif-
 ferent appearances they put on, and these may
 be divided into the following classes. Precious

Stones, ^{Stinks} Quartz, & Jasper, & the Jaspers, & Spars. The
 precious Stones I have thrown into one class, but it is extreme-
 ly difficult to say whether or not all of them belong to
 this class, for the first of them very evidently belongs
 to that of inflammable bodies, as it consumes entirely
 when exposed to the fire, and some of them will not
 melt into glass when mixed with other substances
 Excepting colour then I shall say little or nothing of
 them. They are the following viz the Ruby of a red
 colour and very hard, the sapphire of a blue the topaz
 of a yellow, & the Emerald of a green colour; to these
 some have added the Carbuncle, but it is only a species
 of Ruby of a flame coloured. These have been highly
 valued in all ages, but not equally in all countries;
 they lose their colour on exposure to heat, & during
 the process they emit a flame of their own colour. The
 Ruby very seldom loses its colour on exposure to heat
 I exposed one for 10 hours under a muffle, and it still
 retained its colour, but during that time a diamond
 was wholly consumed.

2. Quartz

Are small white stones full of cracks, the fibres of it
 do not cross one another at straight lines, so that
 when it is struck it breaks into regular angular pieces

They are found on the banks of rivers, and among all gravel; the common white chert they Stone is a very good specimen of them. They are always found in the earth in veins and not in beds, and commonly along with metals, the miners are therefore very fond of them and congratulate one another on finding them, as they are a Messager of their future success. Rock crystal is nothing but quartz crystallized, these are generally very regular and transparent, but sometimes tinged of different colours; they are also of different shapes as hexangular and pyramidal, &c they appear under different classes in the books of the natural historians. We sometimes meet with them of a very pretty yellow colour, & then they go by the name of the Scotch Topaz. Sometimes they are of a purple colour, when they very much resemble the amethyst, both of these kinds are very beautiful when cut and polished.

3 Flint

Are of prodigious variety, but differ in nothing but in their colour and the direction of their fibres, for w^h reason they have given occasion to many names. To this class besides the common gun flint w^h is of a dark yellow colour or brownish cast, belong others that have a dirty appearance, but which when viewed

between the eye and the light have a beautiful olive, appearance. The Cornelian or agate also belongs to this class, consisting of various circular lenses, variously shaded. The 4th genus of the silicious earths is the

Jasper

The Characteristic mark of which is that when it is broke it has the appearance of burnt clay. Of all the species I have mentioned it is found in the greatest quantity, & tho' it is sometimes valued when its colour is pretty, yet the most of the specimens of it are of no value at all. The most beautiful species of it is the Heliotrop which is a green colour, & spotted red, but which when broke across exhibits the appearance of burnt clay. I mention this as a silicious earth, it is frequently impure and blended wth a quantity of O

† Jaspery Spar

or *Sharthurm Scintillans*, which in strict propriety is a species of Jasper, and seems to be nothing else but the Jaspery earth assuming a sparry texture. Its appearance is so singular that when once looked at it is easily known again. Porphyry consists of the Jasper and *Sharthurm Scintillans* mixed, and you

can scarce lift a stone in the Highlands but has this composition. Another compound body called the Granite is a mixture of the Hartshorn Scintillans and Quartz, of this stone the city of Aberdeen is built and of the island of Arran is mostly composed. There is a species of stone found in England it is composed of the Flint and Jasper, it from a striking resemblance is called Pencil pudding stone.

To this class belong sand & gravel. Whinstone is a kind of granite and mixed with S or clay. Free stone consists of sand & gravel combined with different earthy matters; sometimes this matter is calcareous and effervesces with acids, and falls easily into powder, sometimes it contains G, and sometimes the cementing matter is clay which is the kind that is most valued. We sometimes meet with animal and vegetable substances incruated & connected together in this form. The water of Lochmuck in Ireland contains some Lassar dissolved in it, so that it incrustates wood or any other substances that have lain in it for some time. We sometimes meet with the shells of fishes thus joined together. The petrifying V of which we have the best account is a spring in Scotland, the temperature of it raises the Thermometer to 212, and it falls from a

spread of 90 feet in height in irregular jets, so that the neighbourhood around is incrustated with the silicious earth it contains dissolved in it. There is as yet no method known of artificially dissolving the silicious earth in & tho' it is certain these waters mentioned contain it dissolved. In all these forms this substance resists the utmost force of fire without melting, but by this process it is rendered opaque and cracked so as to be easily reducible in to powder, w^h it would be impossible to effect before it is burnt. They are not acted upon by the strongest acids. Alkaline bodies have no effect on them unless we mix them dry, & then expose them to a violent heat when they combine in the most intimate union and form that beautiful substance glass.

We find that during the moment of their union they swell, and are apt to run over the pot in which the operation is performed, & be lost if it is filled above half full. What this is owing to is not ascertained. One very obvious cause is the detachment of the air of the alkali; but this might likewise be owing to some elastic matter contained in the earth itself, as an effervescence happens tho' the α be used in a caustic form. But this also may be false as the α is in contact with fixt air which has contributed to the inflammation of combustible bodies, so that it may attract this air and by that means cause an effervescence.

Another cause may be that the Σ is not very fixed, and by its rising in form of vapour may cause the appearance of effervescence. Every silicious earth may be converted into glass by exposing it to heat along with an Σ or some other body instead of it, and hence the variety of glass according to the nature of the Σ or other substance that is used. The glass made by the common Σ & silicious earth is of a greenish colour, and is called Crown or window glass. This glass may be purified by manganese or magnesia a substance that is perfectly different from magnesia alba, and is of a black colour, & when thus purified it is known by the name of looking glass stone, being used for making these articles. The other substances that answer instead of Σ are calces of Fe . red Fe or litharge is used for this purpose, and make a finer glass but which is of a yellow colour, to remedy w^{ch} it is necessary to add some S & sat. fixed by w^{ch} it is rendered pure. This kind of glass is commonly called crystal, & is remarkably transparent, and has a more beautiful lustre than crown glass has, but it is softer and more easily scratched, whereas crown glass is very hard. The proportion varies, they generally use $\frac{1}{2}$ or at least $\frac{1}{4}$ of lead to the other proportion of sil. earth.

There is another species of ~~fettle~~ glass which is very im-
 pure, and commonly called bottle glass, which is made by
 exposing to heat a mixture of $\square C$ & Silicious \square , that $\square C$
 answers this purpose best w^h has been employed to make
 \square canalic, as it always contains some portion of \square
 but this proportion is generally too little, they therefore
 generally add a little help to the materials. These are
 the different kinds of glass, but their purity depends
 much on that of the Silicious earth made use of, for ac-
 cording to its quality the glass will turn out more or
 less transparent, the best Silicious earths are quartz
 and sand ^{and} which is found in some parts, as for exam-
 -ple Islay sand which is just quartz in powder; for the
 making of bottle glass the common sand of the river is
 good enough. Besides melting other circumstances are
 necessary to be premised, viz to mix them thoroughly
 & then expose them to a red heat for 24 at least before
 they are melted, by which means the efflorescence is hin-
 -dered, they also are partially combined, and the Δ is burnt
 away. Another circumstance is that any vessels made
 of glass must not be allowed to cool suddenly, but must
 be kept in a pretty strong degree of heat for some time, and
 allowed to cool extremely slowly, otherwise the glass will
 turn out extremely brittle, and its durability will be
 greatly hindered, if the particles do not get time to ar-
 -range themselves properly by being gradually cooled.

The ingredients also must be used in proper proportion that the glass may turn out good, & particularly care must be taken that too much of the Σ is not added, otherwise the glass instead of having that property of being acted upon by the most powerful solvents, it will ^{not} dissolve down by water: glass thus made will run 1st deliquium, and the solution is called liquor Silicium, and is the only way I know that a silicious earth can be rendered soluble in ∇ , and if it has been long enough exposed to the fire the whole of it will dissolve. The Silicious earth may be precipitated from this solution by adding a greater quantity of ∇ to it, w^{ch} attracts the Σ so that the ∇ falls to the bottom; the same thing may also be effected by driving fixt air thro' the solution w^{ch} will render the Σ mild. If we collect the Σ after it is thus precipitated it will be found to dissolve in acids, & to form alum with the Θ , w^{ch} shews that the Σ has for its basis the Γ of alum combined with something not yet ascertained. If to three parts of Σ we add only one of Σ , and expose the whole to heat, the glass that is formed will be of an exceeding good quality but will require to be longer exposed to heat than it would have done had a greater proportion of Σ been added, & it is perhaps preferable to add a greater proportion as the redundant part may be forced off

by increasing the heat. When we look into the glass house furnace we observe a vapour rising from the pots which is the redundant part of the C flying off in form of vapour. We also observe on their surface a scum that does not mix with the glass below, it is called by the workmen *gewgaw*, and is produced by ~~some~~^{any} neutral salt that may have been mixed with the materials except Vitre. When the silicious earth is fused by lead less heat is necessary, but one great inconvenience is that the glass is often unequal owing to the gravity of the lead, so that it is not all equally good. This inconvenience has been much regretted by Astronomers, as the fine refracting glasses for telescopes must necessarily be made of this kind of glass, so that many rewards have been offered towards remedying this imperfection.

Many other substances may be employed to fuse the Si . Arsenic fuses with it a white glass, and the white streaks in the stalks of common drinking glasses are done in this manner. Nitre also is employed to fuse Si , & produces a very fine glass as the Ox unites with all the inflammable matters, & escapes wth it in the form of Nitrous gas, leaving the glass perfectly transparent. Borax is the only other compound salt w^{ch} makes a fine glass, but it is apt to become cloudy & to fall in pieces on exposure to the air. This kind of glass is only made in very small quantities

the borax is a very valuable article. When the silicious earth has been fused by any thing but air & it is extremely apt to lose its transparency on being exposed to the fire thro' the medium of a crucible, as happens particularly to the common bottle glass. When thus altered it is commonly called Pearmain's Jopilex.

These are the principal observations I have to make with regard to the silicious E° . I proceed then to the next class of simple earths the

Garnet —

Which very probably is a compound earth, but from necessity has not yet been graduated from the class of simple earths. Its distinguishing marks are that it melts in a crucible into a black glass without addition it also melts when exposed along wth a Jopilex to the flame of a blow pipe. Garnets are little shining bodies that are found in midst of clay, and their beauty increases when they are cut or polished. We sometimes meet with a called Coehle or Shottle by the English miners but in this state it always contains iron. We frequently with a species of it of a dark colour very like to Gum Guaiacum, called Bazzettes, very little of which is to

be met with except in Ireland at the giants causeway and in one of the Highland islands. What is most remarkable is that those which compose the giants causeway seem as if crystallized into regular crystals, the ends of each of which are exactly adapted so as to fit each other. This has afforded great matter of speculation to the Natural historians, but no satisfactory ^{reason} ~~account~~ has as yet been given to account for this phenomenon. I have here considered it as a simple earth, but I am rather disposed to think it a compound of clay &c but as this is not yet clearly demonstrated, it is better to keep it where it is.

With regard to the 4th Species of Simple earths, the

Zeolite

I have much less to say. If the garnet is scarce it is much scarcer, as very few specimens of it can be had; there are some few in the isle of Skye. as it is so seldom met with I shall only mention its general properties. A Species of it called lapis lazuli was first discovered by Cronstedt, by whose experiments it appeared to be a simple earth, tho' Maargraff affirms it contains ϕ . I am told that it is of a shaggy texture but as I never saw any of it I cannot say any thing

with certainty about it. Its characteristic properties are that it dissolves slowly & without effervescence in the Ox & Ox , and upon cooling the solution acquires the consistence of jelly. If a quantity of it in powder is put into Ox it concretes into a solid form. It may be distinguished from absorbent earths by its not effervescing with acids; it is so soft as to be easily scratched by the knife, and ~~it strikes~~ ^{does not} fire with steel. The moment before it melts it becomes luminous; perhaps it may be found to be an impure body but as this is not ascertained by experiment it is better to keep it where it is.

I have now finished the first class of earths the simple; the next ⁱⁿ order are the Compound Saline earths, which are the earths you already know combined with ~~salts~~ acids and appearing in an earthy form. The first species of these the gypsum earths are formed by the Ox & Ox . The Ox & Ox acid not yet described form the Ox ^{class} the Fluor; and the ~~the~~ phosphoric acid & Ox form the Ox species, the earth of animal bones. We have no compound earths into which magnesia enters as an ingredient, ~~as it~~ forms with all the acids substances very easily soluble in V , but we meet with the earth of alum combined with a small proportion of Ox

forming the fourth Species of compound earths viz the
 Argillaceous, w^{ch} being ^{constituted} ~~made~~ from the Talcs
 and asbest, w^{ch} last contain besides a minute propor-
 tion of Silicious earth. I begin then wth the first genus
 the

Gypseous Earths

Which are formed by the union of the $\square C$ and ΘE .
 They are all of them very soft, so that they are easily
 cut with the knife. A Species of it called Alabastr
 has a very fine grain and bears a dull polish, this
 is valuable more on account of its scarcity than any
 thing else. More frequently we find it composed of
 threads or fibres that are very coarsd that run in a
 promiscuous direction; this kind of it is called Plaster
 of Paris, and of it all the stucco for ceilings ^{& statues} is
 made. Sometimes it appears in diaphanous shin-
 ing form, and is then called Muscovy glass, tho'
 in strict propriety it ought to be called the gypseous
 spar as it fibres then have a sparry texture. This
 kind of it may easily be distinguished from the
 Talcs by its not being cleavable and upon being gen-
 tly heated turning opaque & brittle. Of the same
 sparry texture is the lapis Bologniensis w^{ch} has
 the property of shining in the dark; but of it afterward

We sometimes meet with it hanging from the tops of caverns, when it is called stalactical gypsum. In all these forms it is soft and if it is pure it does not effervesce with acids. The principle property for which it is valued is that when heated above 212 it turns opaque and easily hardened and if when in this state it be reduced to the consistence of cream with water and poured into a mould it soon becomes solid and during its change of form it expands so as to take a very accurate impression from the mould, so that by this it may be distinguished from all other earths. During this process heat is produced & is easily accounted for from its change of form. It has some little ^{solu} solubility in water, and when the V is evaporated from a solution it crystallizes in form of selenites. It is not found in extensive strata, but interrupted or imbedded in clay. There are great quantities of it found near this town & it is owing to this that the

waters are so hard and disagreeable. Gypsous earths were till of late considered as simple earths till Mr. Maargraff shewed in the clearest manner that they were composed of $\square C$ united with the O . For by boiling in a solution of vegetable S he obtained a quantity of Nitriated tartar, and by adding to the $\square C$ thus decomposed some O he again produced the Gypsum with all its properties.

In its natural state it contains a good deal of water in its composition, w^{ch} adheres to it and can be separated by exposure to heat in a crucible, if after this it be made into the consistence of cream with water after standing for some time it turns solid, & during this change it expands so that if it be laid on a shell it takes from it a very accurate impression, and by this method a number of very pretty figures may be made out an exceeding cheap rate.

When Gypsum is perfectly pure it resists the utmost force of heat but it may be melted in the focus of a burning glass and this is easier done on the sides than on the ends of its fibres. It is more fusible than any of the tutters mentioned earths. Acids have no effect on it as its basis is the O but by adding to it a S it is decomposed, and the O forms wth the S a Nitriated tartar, & there is precipitated a $\square C$. If Nitre is used to decompose it the O lays hold of the S upon the application of heat, & the O escapes leaving the $\square C$ behind, hence

you see that Nitre may be used to decompose this earth
or this \square may be used to decompose Nitre for the sake of its \times
When fused along with Borax it forms a yellow glass, but
if too much of the gypsum is added the glass turns out
whitish.

The 2^d genus of the compound earthy substances are the

Fluors

But I shall here take notice of a substance that used to
be clasped along with the gypsaceous earths, and was called
the gypsaceous Spar or Marmor metallicum, it is 4 times
denser than ∇ . It appears by experiment to be a compo-
sition of \triangle & \square . It has likewise got the name of the
Sparthum fusibile from its being of use in the fusion of
metals, but this property is not peculiar to it but
also to the Fluors we are now considering.

Fluors are very in appearance and composition and
have likewise been often clasped with the gypsaceous bodies
but they do not after being calcined & formed into a
cream with ∇ concreate into a solid mass as the gypsaceous
earth do. They are in the form of cubical masses and are
always semitransparent and of different colours as red
blue green &c, and according as they show one or other
of these colours they are called false precious stones of
one kind or other. Whatever be its colour it has always
the property of shining when heated, hence it has been
called the phosphoric Spar, and by this property you can

distinguish it in a moment. By this operation it always loses its colour if it had any, and can never again be made to shine in the dark; the colouring matter therefore is not metallic but very volatile. On being thrown into the fire it crackles and is lost if it is not previously powdered. The term Fluor would readily make us imagine that it melts by itself but this is not the case: when melted along with the Δ it forms a corroding glass which eats holes in the strongest crucibles. There is none of it to be found in Scotland, but it is got in England at Derbyshire and Cornwall. Mr Cronstedt a Swedish chemist shewed that these fluors contain an acid which differs from any hitherto described, and has a weaker attraction for absorbent earths than even the \ddagger . Accordingly if I put a quantity of fluor into a retort and pour upon it a quantity of Oe and distill with a fire gradually increased there will arise a sulphureous acid, but if I have previously consumed the Δ of the fluor by keeping it for some time heated so as to be luminous in the dark there will arise an acid with some downy substance that sticks in the neck of the retort upon holding a burning coal near it falls back into the retort. The acid which comes over corrodes both the retort and the receiver. The Oe is preferable for decomposing it on account of its fixity. If there have been put into the receiver quantity of water the acid increases its

surface with a white crust. If put this acid into a bottle with some spirit of wine it produces the same appearance and if it is kept for any considerable time the spirit becomes perfectly solid. How it possesses the property of changing spirit of wine into flint unless it has already flint in its composition is not easy to see, nor has this been clearly demonstrated. We have no method of keeping this acid as it ~~does~~ corrodes every thing we put it into, and will corrode a design on glass the same way as aq. Fortis will do upon Z .

There remains behind in the retort after the distillation (when the O has been used,) a gypsum, w^{ch} shews if its component parts are the L & C and F fluor acid. Dr Priestly indeed denies this but very probably he was mistaken in the kind of stone he used.

Every time you distill this acid even never so often it still corrodes as much as it did the first time, and hence the origin of this acid is so doubtfull. If you add some of it to lime ∇ there falls to the bottom a powder which has all the properties of a fluor and particularly that of shining when heated. This acid has not been examined thoroughly so that much remains to be said concerning it. It has the property of forming with the veg and fef. S and also S substances of a blue colour, insuble in ∇ or in acids.

It does not dissolve O Cork, but it dissolves Q and D
 These are the principal observations with regard to this
 substance which has not been applied to any useful
 purpose.

\square of Animal Bones

Every one is well acquainted that the bones of all
 land animals contain a considerable proportion of
 earth, which is of the same kind in every animal. This
 \square is soluble in the A , so that by steeping a bone in a
 quantity of it, it becomes perfectly flexible. This is some-
 times done by anatomists to shew the texture of bones.
 Bones upon being long exposed to the air become white
 and porous, the glutin by w^{ch} the cartilag fibres are con-
 nected being dissipated and destroyed. The \square of bones
 has long been known & employed by the Chemists for
 many useful purposes as it is incapable of being
 melted by the strongest fluxes. It was formerly
 considered as a simple absorbent \square , and is still re-
 tained as such in some of our Dispensatories; Dr
 Black also was of the same opinion, but he afterwards
 found out and shewed by dear experiments that it
 was a compound body, and that therefore when it was
 used to absorb acidities in the stomach, it was apt to
 deposit in the stomach an \times full worse than that w^{ch}
 it was employed to absorb. It consists of the \square & C

united with a peculiar kind of acid called the phosphorine acid w^h has a very weak attraction for ϕ , and is exceedingly fixt. This acid seems not to be the produce of animal bodies but is contained in the common kind of grain. When more of it is contained in the body than is necessary it passes off by urine, and accordingly we find that some of it is contained in that fluid when a redundant quantity of this acid is contained in the body it dissolves the earthy parts of the bones w^h escaping by the kidneys form calculous concretions w^h are found to consist of a quantity of earth of bones and a large proportion of phosphorine acid.

There have been two methods recommended in order to decompose this acid both of which I shall mention longer. The first of these is to take of bones perfectly dry Lb. i. to dissolve these in a sufficient quantity of O. then to add about $\frac{1}{2}$ lb. of O. diluted with its weight of V. a powder immediately will fall to the bottom which is a gypsum formed by the C. of the bones & the O. w^h is to be separated from the clear fluid w^h consists of the phosphorine & marine ϕ . These two may be separated by taking advantage of the degree of volatility of the latter, and upon heating it nearly red hot there will remain a crystallized mass that mells upon

being heated red hot and as is perfectly fixed. This is the Phosphoric acid, of which if the operation is well performed will be got from the above proportion of ingredients from 3 to 4 Ounces. After having got this acid perfectly free of the Ox it will be necessary to dissolve it in a small proportion of V and to filter it, and to again dry it and dissolve & filtrate it and repeat this a 3^d or even a 4th time to free it of any gypsum w^{ch} it always is mixed with. And it will then be got perfectly pure.

The other way of decomposing this acid is to add to 2 lb of the bones burnt & powdered $\frac{1}{2}$ lb of Ox diluted with its weight of V , to let these stand together for a day frequently stirring them, to add after that about a Chopin of V , and to pour off this after it has stood for several hours, and to squeeze thro a linnen bag. To take this solution and evaporate it in a broad earthen vessel, to dryness. Then to filtrate & dissolve it 3 or four times to free it from any gypsum that is dissolved in it as in the preceding operations. The phosphoric acid has but a weak attraction for O in the common heat of the air, yet it is so fixed that it will decompose even the Ox when heat is applied. If

urine is evaporated to a 1/3 part of its original weight and set in a cool place small crystals will form in it generally called sal miracismus, which are composed of the δ and the phosphoric acid. If we saturate this acid with α & it forms a salt that is transparent when heated but that grows ^{opaque} on being cooled. This acid has the property when distilled along with inflammable bodies forming the phosphorus of Hunkel, so that when once we have got this acid pure by itself the making of this acid substance is perfectly simple. When we come to Able bodies we shall have occasion to remark that this acid is not a pure body but like the cream of tartar has combined with it a portion of Π which it is impossible to separate. These are all I have to say wth regard to the Π of animal bones.

Magnesia forms with the silicious earth a substance called Steatites or soap rock which is found in England and cuts very like to hard soap, but when heated it becomes perfectly hard. Of this Mr Pott proposed to fashion statues. Port-
-sey marble consists consists of Magnesia & the silicious earth. The last species of absorbent Π viz the Π of. Hum was imagined to form with the α nothing but alum, but it has been found that when united with a small proportion of α it forms the last species of the compound earthy bodies viz the Argillaceous earths.

Argillaceous Earths

142

Or clays do not support plants well but are rendered better in this respect by a mixture of sand. When it has been kept for some time red hot it acquires a stony hardness and strikes fire with steel. It is made use when made into a durable paste with ∇ for fashioning earthen vessels for the purposes of life, and by mixing with the paste a quantity of sand the vessels are much less liable to crack by being exposed to heat. Argillaceous earths when pure resist the utmost force of fire but this is not the case when they contain ∇ or all the clays in this country do, if they are pure they become white after being burnt, otherwise they are not pure. They are found in strata in distinct beds. The whole of their variety is from their colour as their consistence makes no difference. The purest kinds of it are found in China and Japan, hence the beauty of their earthen ware called porcelain.

The argillaceous earths as we have little else but colour to distinguish them may be divided into 3 classes. 1st Those that are perfectly pure. 2^d Those that have a mixture of Δ and 3^d Those that have a mixture of δ . To the 1st of these class belongs the clays of the Chinese and Japanese, to the 2^d the common tobacco pipe clay, & to the 3^d the common clays found in this country all of which have a mixture of δ and Δ . Pipe clay contains some Δ , which makes turn perfectly black if burnt in a fierce heat, but when it is burnt slowly it appears white externally, and it is necessary that during this process it do

not come in contact with the flame of the fuel. I have tried to purify the pipe by adding nitre to it and exposing in these circumstances to a violent heat, with a view to consume it Δ , but the δ which remains always attracts from it its ϕ so as to clog it. Tho' the earth of alum is commonly said to be the basis of the argillaceous earth, yet it likewise contains some silicious earth. For if we by an artificial process add to the Π of alum some ϕ it will not form a clay but if to these besides we add some powdered gun flint, and if all of these ingredients are perfectly pure, a clay equal to that of China or Japan will be formed. The argillaceous tho' said to be insoluble in ψ yet has a little solubility in that fluid ζ . ψ being capable of dissolving one grain of argillaceous earth. We can discover when ϕ contains clay dissolved in it by evaporating it when it yields the clay crystallized in the form of the micae of Talk we are distinguished by their plated texture. These plates are elastic and may be divided into a number of smaller ones with a knife; they are transparent and very like the gypsaceous char, from which however they may be distinguished by their elasticity and by not losing their transparency on being heated. It as well as all the other earths does not melt without addition, but does it very readily when a proper flux is added. It is found in different forms, sometimes in parallel plates that have got

The name of Muscovy glass, and were used formerly instead of that article by way of window glass. It is also found in contorted pieces like knots of various colours, all of which owe their colour to the iron they contain. To the class of earthen I am speaking of but nearer to that of the clays belong Chert or Flints we consist of strata parallel to one another and may be considered as talks formed from an impure species of argillaceous earth; and to this class may be referred alum stone as I before mentioned consist of clay & sand. The talks are frequently mixed with iron & ores, and might be thought to be an inconvenience to separate them but they melt very readily along with metals. Tunbridge clay is used in the making of glass consists of argillaceous earth & talc. There is one experiment not wanting to certify whether the argillaceous earth and talc are the same and differing only in form. Haargraff has attempted some experiments on this subject but it does not appear that he has succeeded.

These talks do not appear all of them to be composed of Ox and Si of alum, Mr Haargraff found that some species of it contains a little magnesia for by boiling $\frac{1}{2}$ of salt in $\frac{1}{2}$ of Ox he got 3 grains of gypsum & spoon salt; I do not know what kind of salt he made use of but very probably it was an impure one. To the class of the micae has been referred black because

it has scaly texture, but it is improperly used in this manner as it is a composition of tin & and Δ . There is another set of earthy bodies (the Asbestine) that possess the property of micae except in texture, that is are unfusible when pure, and easily melted when mixed with Δ but are of a fibrous texture whereas the lallos are of a plicated texture. We sometimes meet them of different colours, those that have any colour but white contain Δ and are easily fused, whereas if that contain no Δ are infusible. One genus of this called Byssos is remarkable for not being consumed by fire and from its being employed by the ancients on that account to contain the ashes of their dead when their bodies were burnt on a funeral pile. Very little of it is to be found in modern times; it is sometimes twisted and of various colours. I tried to make cloth of it by spinning it along with flaxen cloth, but upon burning the flax it fell to pieces. It was tried in Italy to make it into paper which might be written on with a solution of copperas, but was never applied to any useful purpose. Tho' some of these bodies I have last mentioned do not with great propriety come under the class of Argillaceous earths, yet they may be allowed to continue there till future experiments give more light upon the subject.

I have thus finished those earths I proposed to give you an account at the beginning of this class of bodies, which you will perceive to differ very much from one another with regard to all the effects of heat and mixtures.

I shall here take notice of a substance that does not properly belong to any one of the classes of the earthy bodies, as far as has been yet discovered. but from its appearance it would seem to belong to some class of this species of bodies. It is called *Trispolitana* from its being found in greatest quantities near *Trispoli* in *Sicily*; the *Venetian Trispoli* is the purest species of it. Some think it to be a species of putrefaction from its appearing of a woody texture but how it is produced, or to what class of bodies it properly belongs has not yet been discovered for it has no resemblance to any body that I know. It is of a very hard texture so that it is employed in the polishing of glass and sometimes of steel. its particles when made into a paste with *V* and heated adhere so strongly as to strike fire with steel. It has been supposed to belong to the class of argillaceous earths but upon boiling it in the *Et.* I could obtain no alum from it. There is one purpose for which it is much admired, viz. when a paste of it is heated in contact with a seal it takes a very accurate impression from it. Thus if we

take some powder of it and lay it upon a seal of glass
then apply a wet cloth to it so as to wet the top of it
then place the seal along with it under a muffle
and allow it to become red hot, we may then draw
it out when it will have taken a very accurate im-
pression, and these pastes are very much admired
This is not a modern invention as there are some
ancient seals I have seen which upon examination
I found to be formed in this manner.

Having thus finished the history of all the earthy
bodies I propose giving you ~~some~~ account of the
uses that some of them are applied to in the arts
I do not mean to mention their use in all the arts
but in the three following viz in Medicine, in ren-
dering the soil fertile, and in the manufacturing
of earthen ware, and as I shall include all these
in one nights lecture, I can only give you the
great outlines.

There are few substances of this kind now employed
in medicine besides what formerly was, the know-
ledge of Chemistry having now shewn the improp-
riety of these substances which were kept in the la-
boratory of the Apothecaries under such variety of
names and appearances. It is now well known

that no substance can have any effect on the ani-
 mal economy that is not soluble in any of the fluids
 of the body. As lime is very much disposed to dis-
 solve stony concretions, actually making those it
 are infused in it to fall to pieces, hence it was formerly
 very much used in all calculous, and other cases
 where there was suspicion of a stone in the kid-
 neys or bladder. But it did not answer the great
 expectations that in many cases were hoped from
 it as it is very seldom it can be got to the bladder or
 kidneys in active state, as there is always a fermenta-
 tion going on in the stomach it is very apt on be-
 ing received into that organ to attract that air and
 so to become inactive, besides should it enter the blood
 it has the whole course of the circulation to pass
 and even should it get to the bladder in an active
 state it would besides dissolving the calculus pro-
 duce bad effects on that organ. ^{some of} The other substances
 are not acted on even by acids, therefore no practi-
 tioner would pretend to give bole clay or sil carthas
 as they do not dissolve in acids. Therefore the only
 two of them used in medicine are Chalk and mag-
 nesia, the earth of alum being discarded as it
 forms wth acids a sour salt. Neither of these two

52
may be used according to the circumstances of the patient; either is proper to absorb any acid in the stomach but then Magnesia when it meets with an acid forms with it a purgative salt whereas chalk does not purge at all; when the patient is troubled with flatulency, then magnesia may be used in its burnt form but the CO_2 cannot be given in this form safely. All the absorbent earths have a septic quality & ought therefore to be avoided in putrid diseases.

The Earths are remarkable also for affording nourishment to plants; now the soil consists almost wholly of earth which is fertile or barren according to the proportion of each kind that it contains; the upper stratum consists commonly of a small quantity of rotting vegetables, and sometimes ~~these~~ one or two species of salt. The salts they most commonly contain are vitriol. acid tartar or Sal Nitre but in no great quantity so that these salts have no effect, the only salts that are of prejudice to a soil are those which contain S . All soils contain as principal

clay, sand and DC, so that by carefully examining them
 you can easily discern w^h of these kinds that prevail in any
 soil upon digging down a foot or so if Chalk be discovered
 below the surface then the soil is mostly composed of DC
 w^h is a favourable appearance. Besides clay and animal
 or vegetable substances in a state of putrefaction, the soil
 requires to be supplied with a proportion of sand, in order
 to allow the tender roots of the plants to penetrate thro' its sub-
 stance, and that water may be supplied to it with the greater
 freedom, & as clay parts with its water with difficulty so
 clay is of service to sandy, and sand to soils that have
 too great a proportion of clay. Besides & the plants must
 have air supplied to them which they get from two sour-
 ces viz from the atmospherical air above ground, & that
 yielded by the putrefying vegetable or animal substances
 hence some soils that contain none of these substances and
 are on that account perfectly barren, become fertile imme-
 diately upon adding to them a quantity of dung. Some-
 times all the ingredients are present in a very just proportion
 yet the plants grow but weakly, owing to the soils contain-
 ing some salt that is composed of iron; this may be reme-
 died by adding a quantity of fixt & or the ashes of burnt
 vegetables w^h will decompose this salt and render it in-
 capable of entering into the vessels of the plants. DC also
 will be of use for this purpose as they are capable of
 decomposing the salt of iron, if the soil contains any
 compound salt they are not capable of injuring the plants

near so much as the iron. Sometimes the plants have too much vegetable life which hinders them from putrefying. in this case tilling the ground is of infinite service. The $\square C$ is here of very great use, it ought to be used in form of powder, for w^h purpose it will be necessary to burn it into lime, and then to reduce it into powder, but in this case it is no more than the same as if it had not been burnt except that it is more easily powdered, as it attracts its fixed air from the atmosphere before it has been added to the soil. Indeed it is sometimes advisable to lay it on the soil in as active a state as possible, for by attracting fixed air from the vegetable or animal substances it more speedily promotes putrefaction than if it had been used in a crude form. If the soil contains but little vegetable matter then the $\square C$ when added will be of no service. it therefore is necessary that the use of this substance be under proper management for the producing of ^{vegetable} ~~animal~~ growth.

Many substances that are mistaken for calcareous marles and are employed instead of these substances for fertilizing the ground, are nothing but species of clays and are of no use but when the soil is sandy. Common salt has been used in small quantities to promote the putrefaction of the vegetable or animal substances, as it is found to have a septic quality when used in small quantity scing one ounce of matter will rot sooner when 35 grains of common

salt is added to it, than two Drunks of matter will do by themselves: but for the purpose of fertilizing it is not so efficacious as the DC.

I shall next take notice of those earthen vessels that are formed into vessels for the purposes of life. Earthen are the best bodies for being formed into vessels as none of them but two the DC & Gypsum are apt to be acted upon by acids or other bodies besides the cleanliness & consequent healthiness that attends the use of them, & their being easily fashioned into any shape that is most convenient. The argillaceous earth is the only one that forms with a ductile paste it therefore is the principal ingredient in every species of earthen ware. But as it is apt when used by itself to become brittle when heated to any great degree, and to be liable to crack: when boiling is poured into them, therefore it is necessary to add something w^{ch} might counteract their expansion and increase the coherence of the particles as we would wish to have impervious to any fluid; such a substance is sand w^{ch} when added in due proportion makes them less liable to crack: by sudden heat or cold and when they are porous after being burnt they are then covered with varnish. The coarsest earthen vessels are made of the common clay of this country w^{ch} when freed of it makes tolerable good ones, they are then covered with a varnish made of the oxides of lead; and by mixing manganese they are made of it

different colours. There is a species of ware it is made of
a mixture of argillaceous earthen and a kind of rotten gra-
nule. This is called Delfts. The common white stone ware
is made of flint and pipe clay, and is yellow if the propor-
tion of the flint is great, it is varnished by bringing it in
contact with the vapours of common salt. The finest spe-
cies of earthen ware is Porcelain it was originally made
by the ancient Japanese, and was far superior to any made
now, whether it is owing to the scarcity of materials, the
dumy of operating, or the hurried proceeding, in conse-
quence of the now greater demand for that article.
after they have been fashioned they are glazed over
with common crown glass; it is necessary that all
these varnishes contract equally wth the materials
of w^{ch} the vessels are composed, hence it is found necessary
to add to the calx of it with which the yellow kind of
earthen ware are glazed some a particular proportion
of earthe. Porcelain has attracted the attention of the
world more than any other species of earthen ware.
The manufactory of it at Saxony comes nearest to that
of the ancient Japanese. Acamur who travelled to
China sent two bodies to France of which he said that
all the porcelain was manufactured, but he did not
find out the nature of them. They are called the Faolin
& Petunoe. It has since been found that the first
of these is a perfectly pure species of argillaceous earth

151
and that the *Pectunoi* is a species of fluor, to which when a perfectly pure argillaceous earth is added, it is capable of forming porcelain. Of this fluor there is plenty in Britain but little or none of pure argillaceous earth. All the species of porcelain are burnt twice or three times at least but some of the more ornamented species are burnt four or five times. First the materials are fashioned into the form of the vessel upon a wheel and exposed to a violent heat by which they become whitish and semi-transparent, they are then taken out and wetted with water and sprinkled over with powdered glass which adheres to their surface by means of the water, they are again exposed to heat & melts the glass so that when taken out they are still white and ^{very} transparent and varnished over. Then if any design is to be put upon them it is now done, if it is blue the most lasting colour it requires to be put on first as it takes the most violent degree of heat, after it is put on the porcelain is again heated. after that if it is necessary to put on a brown yellow or dirty red colour it is now done and the ware heated a 3^d time. If after this they put on a pink or a rose red colour it is now done and the ware heated a 4th time, & last of all if it is to be gilded that is now done and they are heated a 5th time. The porcelain must be burnt in vessels so as to prevent its coming in contact with the flame, for if it was so to happen some of the colours would not melt.

especially if the fuel is coal & contains $\frac{1}{4}$ of mixing with the colouring matter entirely deprives of its melting property and as all clays contain $\frac{1}{4}$ & some of them $\frac{1}{4}$ hence they are unfit for the manufacturing of porcelain unless those of China which are perfectly pure.

The last circumstance I shall take notice of is the art of imitating precious ^{stones}. This has been attempted even from the time of Democritus who is the first upon record that has tried this art. They have however always failed to imitate the chief of the precious stones viz the diamond. All the substances with which we attempt this work are bottom glass, and that kind we contain a great proportion of & is generally used. The French glass is said to imitate the diamond in some degree but wants its characteristic hardness. It is apt to be of a yellowish tinge & may be removed by adding a little O . Glass may also be made to imitate the other precious stones by adding different substances to it when melted. The Emerald may be imitated by adding to it the rust of $\frac{1}{4}$ or copper precipitated from its solution in A by a hand continuing the heat for some time, we must be managed with great caution else it is apt to lose its colour but this may ~~raised~~ restored by throwing into the furnace a quantity of straw ^{the smoke of} it may come in contact with the glass. If you want to imitate it may be done

by adding to glass a calx of V. To imitate the ruby is more difficult it must be done by adding O precipitated from its solution in aqua regia by means of A. If you want to imitate the sapphire it is the most easily done of any and when once got is the most durable of any, it is done by adding to glass a calx of Cobalt, a semimetal afterwards to be described.

Particoloured glass seals may be made by having several ~~frust~~ ~~frusts~~ ~~frusts~~ of ~~frusts~~ ~~frusts~~ glass of different colours, and by laying a layer of one above another according to fancy. Besides what I have now mentioned you may produce on glass all the different colours as is done by the pencil upon canvass, so that you can paint on it perfectly easily, as all the nicety consists in applying heat properly to them.

+ Vessels of China may by washing be deprived of any disagreeable odour. But those of common earthen ware cannot be rendered perfectly inodorous.

20

I now proceed to the next class of the Objects of
Chemistry viz the

INFLAMMABLE BODIES

Which have the property when heated to a certain degree of becoming luminous. After the heating cause is removed continue to emit heat & light from a source within themselves untill they are perfectly changed into a substance different from what they were before. Hence it may be concluded that they contain all of them one common constituent part the Δ . They require a certain degree of heat to set them on fire & also a constant supply of fresh air. The degree of heat required is very different, some of them require only the ordinary heat of the air to inflame them. Others a much greater heat. The greater the quantity of fresh air they come in contact with during their inflammation the more violent degree of heat do they produce, & the more perfectly ^{and suddenly} are they changed. Thus if we were to take a common candle & separate its wick into smaller threads & put on them separately, the same quantity of tallow, it will produce a greater degree of heat & light & be more suddenly consumed. Also if we bring it in contact with a great quantity of air by using the blow pipe we can melt with the flame of a candle O & S & Metals without this contrivance require the strongest heat of our furnaces to melt them; & by this simple apparatus we can by trying the effect of heat on any substance in small determine the effect of the strongest heat of our furnaces on a larger quantity, it being unnecessary to place the particle of the body to be examined on a piece of charcoal to hinder

the heats escaping from it too fast.

Inflammable bodies are of very great variety, & belong to both the Animal, Vegetable & Minérale kingdoms. We may perhaps derive them wholly from the Vegetable kingdom, as the seeds of vegetables have the property of increasing into a vast size, & these are most Δ ble if they grow in a dark place, probably this Δ they contain is mostly derived from the rays of light. All Δ ble bodies are either natural or artificial & the last of these require principally the consideration of the chemist. In both of these we must begin by considering the most simple by which we will be enabled to understand better those that are more compound. The most simple are those whose compounds adhere together wth the least force. The chief of these are the Phosphori, the name of w^{ch} indicates the property of shining in the dark, but some of them have also the property of taking fire on exposure to the air, & on that account have sometimes got the name of Pyrophori or fire carriers; but the term Phosphori is used to indicate both of these properties, & I shall consider them under that general name, first they being the most simple of the Δ ble bodies, then the next in order are 4. Charcoal Str of Wine, oils, & Bituminous substances by w^{ch} I mean all those found in the bowels of the earth. Many substances have the property of the word Phosphori in its literal acceptation viz that of shining in the dark, & some of these have it most remarkably after exposure to the sun, likewise some animals have this property viz the glow worms & some species of flies; also some bodies when in a state of putrefaction as rotten wood, & some fishes. These I do not consider under the article of phosphori. The sea during a smart breeze

at night also appears luminous, but this is owing to a putrefaction occasioned by the fishes that are in it, & may be imitated by putting into vials some fishes & allowing them to putrefy, we will succeed better if a little O is added wth the ingrest quantities it be antiseptic, in small quantities it hastens putrefaction, so that if this water is agitated in the dark will appear luminous. To the class of Phosphori has been added those bodies that when struck against one another in dark appear luminous, as gun flint & refined sugar & laps when struck have this property, but this is Electrical as it can only be produced by non conductors whereas metals that are not conductors do not produce it.

Some of those I consider under the article of Phosphors have the property of shining in the dark & burning wth all the violence of an Aële body on exposure to the air, of these the principle is the Phosphorus of Hunkel, w^{ch} possesses both of these properties in a remarkable degree, to them also belongs the black Phosphorus or Pyrophorus of Homberg, w^{ch} becomes red hot & burns inflammable bodies when brought nearly^m but does not shine in the dark, also there are others that shine in the dark & do not burn inflammable bodies, these are the Gypsos D° when prepared after a certain manner. We begin then wth that substance that possesses these Properties in the greatest perfection

Phosphorus of Runkel

Is a transparent & colourless body like glass, but is soft & has very much the consistence of wax, & it is heavier than water; when kept some time below the surface of O it is necessary to do to hinder it from taking fire. it grows off a white colour externally & then it very much resembles white wax, & when this outer crust is removed internally it is transparent. I shall first consider it as being subject to inflammation, during w^{ch} it produces the most violent degree of heat & light of any inflammable body known, but must have a constant succession of fresh air; hence we can perform any operation upon it & subject it to a very considerable degree of heat in close vessels. If heated to 96 it melts into a transparent fluid & soon takes fire, & if a drop of it in this state falls upon a hard it produces violent pain & the wound afterwards is very ill to heal, as the matter it leaves behind is very acrid. This matter is deliquescent & is of an orange colour. Phosphorus is admired for the small degree of heat it takes to inflame it, & for this it is chiefly esteemed by those who go about to chew tobacco with it. One of these

is to snuff out the candle & immediately while it is 165
yet hot to apply to it a pen knife previously lanced
with a little of the phosphorus, so that the candle
soon seems to inflame of itself with great violence.
Another is to wrap a little of it lint, & to desire
any person to pour warm water on it, the phospho-
rus takes fire by the heat percolating the lint &
produces a pretty smart inflammation.

The substance left after the phosphorus is burnt is
heavier than the phosphorus before it was consumed &
this was clearly shewn by M^r Margraaf who tried it
in a ballance. What this is owing to is not certain, whe-
ther it gains this weight by attracting moisture or not
but I think it ought to be enquired after, & I think
this would be a very easy matter, by putting this
residuum into close vessels & exposing it to heat to
see if it contains any aerial matter. This residu-
um runs prodigiously into an x substance w^h is the
basis of the phosphorus. This x is very fixt & can
not be raised by any degree of heat without addition
& on that account it decomposes even the Δ in a strong
heat tho' it does ^{not} do this in the ordinary heat of the
air. If you take this x and mix it wth charcoal
dust, & expose it to heat in a retort, it will unite wth
the Δ & destill in the form of phosphorus; & if we
collect the x after every time we inflame the phosphorus
& destill it again wth Δ we may produce phosphorus
as often as we please, but this must be done in close

vessels. The nature of this x was unknown till it was explained by that accurate Chemist Mr. Margraaf of Berlin. Stahl who had obtained great credit otherwise in the Medical world, said that this x was the O_t , & they took this on his word as otherwise he was a person of great merit & this hypothesis was universally believed even when Mr. Macquer wrote his Chemistry, till Mr. Margraaf proved the properties of the phosphorine x in the clearest manner. This shows how cautious we ought to be in adopting any theory that is not supported by experiment. The only experiment that Stahl had was that \odot when thrown into the fire burned wth a flame similar to that of phosphorus. Mr. Margraaf tried a great many experiments on this x , he mixed it with the other x but does not tell us for wth reason but his experiments shew that other x particularly the O_t has a stronger attraction for the Δ than it has. He distilled the O_t from phosphorus & it came over yellow colour & sluggish having attracted from the phosphorine x its Δ . This was not the case wth the O_t , he added to Zi of it Zi of phosphorus in a retort, w^{ch} he joined a receiver, & set the retort in a pit of cold sand, immediately the retort was filled wth orange coloured vapours, a hissing noise was heard & the materials exploding wth great violence burst the vessels; All this happened in as short a space of time as I have taken to tell it you, & it shews that the O_t has a stronger

165
attraction for the Δ than the phosphorine & has the
O γ being converted into Oous gas during the operation
When he added O γ to phosphorus no decomposition
followed. L γ have no effect on this body, composed
salts have none, nor have O γ bodies any. This
shews that this is a very simple body composed
of two ingredients. It has also another property
for w γ it is much admired. That of shining
in the dark. This is a species of inflammation
& on that account it may be said to have two
inflammations, the 1 $^{\text{st}}$ when it takes fire & con-
sumes w γ violence, & the 2 $^{\text{d}}$ when it shines in the
dark. During w γ the smoke arising from it is very
evident, as also the garlicky smell it emits, & tho
it does not burn like inflammable bodies, yet
it is gradually consumed so that this ~~first~~ ^{2 $^{\text{d}}$} inflam-
mation differs from the former only in degree.

There are many other substances that as well
as phosphorus have 2 inflammations tho
not in so perfect a degree. For Example Δ , but
this does not hold true w γ respect to it in the or-
dinary heat of the air, but may be shown by ta-
king a hot poker & throwing upon it a quantity
of the Δ the particles that fall on the hottest
end of it will consume, those on the part farther
up will melt & seem to suffer no change, but
if we carry it into a dark room we will very
readily perceive a blue vivid flame arising

from them, & the whole will insensibly be consumed. This shews it to have two inflammations. & by this method without producing any explosion we can burn all the $\frac{4}{5}$ out of gun powder, by taking a hot brick & throw on it a little gun powder, the first or 2^d particles will explode, but if we continue to throw it on by intervals we will find that at last it will not go off, & if we remove it into a dark place we can perceive a blue lambent flame to arise from it, & upon examining it after it is cold we will find that the whole of its $\frac{4}{5}$ is gone off at a heat not sufficient to kindle the residue. These 2 kinds of inflammations may also be perceived in a common candle, if we put it out in the dark by turning it down & choking it wth the grease then upon turning it up the vapour arising from it will appear luminous. Some persons cannot be observed this appearance, but it may be seen by any one whose eyes are not very irritable so as to be dazzled on passing from a light to a dark place suddenly. Phosphorus is said to shine ^{in dark} in the old rusty head of the art, & I have found that it does not do so very visibly when the temperature is below 32, & when below 24 it does not shine at all. From the peculiarity of this substance Mr Boyle endeavoured to calculate the divisibility of light, he found that it shone equally visible in all the parts of a room 12 feet square

for 12 days together, & so draw his calculations accordingly. As it is soft like wax it is moulded into little cylindrical pieces, so that when one writes with it on a piece of paper, the writing appears luminous in the dark, & if we take & heat the paper a little before the face it burns out writing. In consequence of its shining in the dark it is used to make persons hands & face luminous. For this purpose it is used to be dissolved in oils, & especially that of cloves, but this is a dirty way of operating, & oil of cloves particularly is apt to inflame the skin, it is better to dissolve it in Spt of Wine an ounce of w^{ch} takes up just a grain of the phosphorus, & a tea spoonful of this solution will be sufficient to make the hand & face appear luminous. This solution may be employed in a more useful manner, if a little of it be poured into a vial about one third full of water, it will fall to the bottom below the ∇ , & when we shake the bottle so as to bring it in contact with the air above the ∇ , the whole becomes luminous so that you can easily observe the hour of the night by looking at your watch held near it, hence it may be employed for the Military lantern & it answers better for that purpose than any other contrivance. This is the most useful & indeed the only useful purpose, this wonderful preparation has been applied to.

I come now to consider the method of making it. It was first by a citizen of Hamburg named Brand who worked on urine in the search of the philosopher stone. After that it was also made by Runkel who knew only y^t it was got from some part of the human body & accordingly set to work & obtained it from urine. After this it was made by Mr Boyle who indeed made the same discovery. Afterwards the operation was considerably improved by Mr. Kellot, but still it was a tedious & uncertain process as it could not be seen without staying 24 hours in the laboratory. Mr. Margraff after this published a method of making it w^h is the following. He took of putrid urine evaporated to a 36 part of its weight till about the consistence of honey of this he took 9lb. to this he added 4 of *plumbum corneum* & 1 1/2 of charcoal. The great advantage of this he put into several small retorts & distilled away the more aqueous part. Then he allowed the whole to cool & put it into other retorts capable of suffering a great degree of heat, & by this last part of the operation the phosphorus came over. The great advantage of this way of his is in dividing the operation for if it were to be continued in the first retorts they would infallibly crack; also another

advantage is the smallness of the retorts used by w^t. 1891
they can be more equally heated. Of 1st advantage the
Pumblum corneum is for this operation I know not, but
I have often seen of it disadvantage as it is apt to cor-
rode the retorts. Mr Maargraf also shewed that the
phosphorine & of the urine was combined w^t a quantity of
S, & the salt formed by their union is called Sal. Siccus
cosmus, w^t forms in urine very readily when evaporated
to the consistence of honey & set in a cool place. That
part of this & also is combined w^t some S & a quantity of
Absorbent \square . & that by adding this & to Sal. S. & a Sal. mi-
crocosmus is formed.

Since the time that Mr Scheil found out the method
of obtaining the phosphorine & from bones in the man-
ner I so fully mentioned to you before. The process of ma-
king the Phosphorus of Blankel has become considerably
more easy. The process is this. Take this & add to
it twice its weight of charcoal dust w^t a little ∇ in or.
do to make it into a thick mass, put this mass
into a crucible & calcine it till dry. Then put the
whole into a retort that is coated, place it in a
furnace apply a fire at first gradually so as not
to crack the retort, raise the heat by degrees to
very strong degree, the phosphorus will distill
over into the receiver w^t must be half full of
water, & not so much inclined as to touch the
mouth of the retort. The phosphorus in this

172 way. It stills in considerable quantity but is in the form of drops. & may be made into small rolls by putting it into a conical glass tube immersed in boiling water the phosphorus will become fluid & congregate into rolls & upon putting it into cold & the whole grows solid. Sometimes it is not so homogeneous as it should be, but it may be freed of any impurities by a second distillation, & will not when thus formed require so strong a heat as before. During the operation only a part of the χ combines wth the Δ , & if we examine the remaining part we will find to be composed of the phosphoric χ united wth a δ , so that this χ may be considered as a salt not perfectly neutral, having in its composition a quantity of δ wth wth it is not fully saturated. This χ is of vegetable origin as is clearly proved by Mr. Haasgras. He took a quantity of all the ordinary kinds of grain as corn wheat beard & mustard pepper &c. These he calcined till all their volatile part was dissipated & they were burnt to charcoal, this he exposed to heat in a retort & from all of them he obtained phosphorus, indeed the quantity was very small, but still it is sufficient to shew it of vegetable origin.

The next set of the phosphoric have a violent inflammation but do not shine in the dark, of these

the most remarkable is the

173

Pyrophorus of Homberg.

Which bears but one inflammation, it is indeed very violent; this takes fire immediately on exposure to the air, a set of inflammable bodies or fire if brought near them. It cannot be kept very long in its first perfection. During its inflammation a disagreeable arises from it, which in common language is similar to that of rotten eggs. It was originally made by Homberg by mixing wth almost several substances about the human body wth he thought necessary to its formation, but since his time it has been found that any thing wth is inflammable will answer instead of any substance about the human body.

Alum however is a necessary ingredient although it has been asserted by the French chymists wth any salt containing the O^t will do as well, but in all my experiments upon this substance I have never succeeded unless when I used Alum.

The process is the following. Take of Alum in powder 3 ounces mix wth it one ounce of common Moscovado sugar, or flour or yokes of eggs but sugar answers best. Heat them over the fire in a common shovel, they will melt into a larry

154
brownish coloured mass; this is the watry fusion of
the salt & the heat must be continued till the
whole of its γ is dissipated, then it may be removed
from the fire & it will at this time be of a ^{deep} brown
ish or black colour, then it must be powdered in a
mortar & again returned to the fire principally
to see if the particles are disposed to cohere together
if upon applying the heat they do not form into lumps
then it is ready for the last operation, otherwise
it must be kept on the fire till the whole as-
sumes a powdery form. Then it will weigh
if properly prepared $31 \frac{3}{4}$. this must be put
into a small bottle, w^{ch} we place in a crucible
having in its bottom a little sand, then the
bottle may be covered up to the neck wth sand
& the crucible set in a chimney surrounded
wth red coals & the mouth of the vial covered
wth a bit of slate or γ to prevent dust from get-
ting in. The heat pervades the sand gra-
dually & the ingredients begin to emit vapours
in this way they must be kept till a bluish
flame appears issuing from the mouth
of the bottle w^{ch} will continue for about a quar-
ter of an hour. after w^{ch} the crucible may be

lifted from the fire & the bottle covered wth a bit
of slate, then immediately invert over it a small
vessel w^{ch} you must press down into the sand
to prevent the air getting in. When it grows
so cold as to allow you to touch then you may
work. The bottle & the matter within will be
found to have all the properties of the Pyro-
phorus of Stenborg. This is a very easy
operation - yet it often fails especially if the
matter be not calined long enough over the
fire so as to be perfectly free of cohesion.

You'll easily see what happens during the
operation, the sugar during the calcination is con-
verted into a charcoal, w^{ch} wth the Δ of the alum
uniting forms a Δ , when exposed to heat in the sand
bath, during the operation the blue flame is occa-
sioned by part of this sulphur consuming. What remains
in the bottle is a quantity of Δ & \square of alum & a little char-
coal. This upon exposure to the air is decomposed by
a double elective attraction, so that the Δ of the Δ com-
bining wth the external air produces a degree of heat w^{ch}
is sufficient to make the whole become red hot. That
it is a double elective attraction is evident there being
four substances viz the Δ , \square of the alum & the external
air w^{ch} acting upon the Δ of the Δ disengages it from

the Θ , w^e combines w^t the \square of the alum. Mr Macquer however accounts for it in 2 different methods. The one is that during the operation the Θ is so concentrated w^t on exposure to the air it attracts the moisture thereof w^t so great a force as to fire the charcoal, but this is merely hypothetical. Another way he accounts for it is w^t the \square of the alum is burnt into lime during the operation, & so raises the required heat by attracting the moisture of the air: but every one knows that it is impossible to burn this \square into lime.

When we add a little \vee to this pyrophorus, a thick substance is formed, the sulphur unites w^t the \square of the alum & forms a hepar.

The last set of Phosphori are those w^t have the property of shining in the dark: & that do not take fire on exposure to the air. These are earthy bodies prepared in a particular manner either combined w^t or not combined with χ . The first of these I w^o speak of is the

Bolognian Phosphorus

Which when exposed to day light for half an hour & removed into a dark place appears luminous; it is not necessary to expose it to the light of the sun but just to the ordinary day light, but no other light as that of a fire or candle than this effect, except the electric spark. It was originally prepared from the lapis Bolognensis a species of gypsum found

184
in considerable quantity in the neighbourhood of the city
of Bologna & was first discovered by one ^{a cobbler}
who being of an idle disposition & not caring to work
much used to stroll about in search of stones &c. from
w^h he might be able to extract some valuable metal
y^t would support him during life: he accordingly hit
upon some of this stone w^h he carried home & put into
the chimney covering it over wth burning charcoal & lay-
ing on the top some bricks. He did not however wait to
see the success of his operation, but returning two or
three hours afterwards was surprised to find the
hearth all luminous y^t perfectly cold. From y^t
time it was generally known but the principles on
w^h it proceeded were first explained by Mr. Haasgraf
he shewed that it might be obtained from any gyp-
som natural or artificial by making it into balls
wth maulage of Gum Arabic & heating these for half
an hour in a strong charcoal fire. The O^f of the gyp-
som combined wth the A of the G. Arabic w^h by the heat
is converted into a coal & forms sulphur w^h mixed wth
the C^o, burnt into lime by the heat of the fire.

He found that these phosphore differed in colour ac-
cording to the kind of gypsum he used owing probably
to some foreign matter the different species contain.

Another more simple method is mix three parts of
quicklime wth one of Sulphur & expose them in a cru-
cible for half an hour to the fire, then they will be

found to have the properties of shining in the dark. for this operation oyster shell lime answers best as it is of a whiter colour. By this method of operating we mix together at first what took a longer operation to effect. This phosphorus when exposed to light in close vessels shines equally as if not in the dark, but it loses its property after some time if it is kept for years in the dark but regains them upon being heated. Father Accario thought that on exposure to light it attracted a quantity of it w^h it gave out slowly in the dark. One likewise adds that if it be exposed to a blue red or any other coloured light that it shines of this colour in the dark; this may be done by exposing it in bottles of different colours, but the truth of his assertion does not seem to be supported by the experiments of others. It also does not seem to be owing to its attracting light. that it shines, but that it is owing to a species of inflammation, for by often exposing it to the light we can burn out all its Δ and so deprive of its power of shining in the dark.

The bodies that shine ^{in the dark} on exposure to day light are numerous father Accario & Mr. Wilson of London found y^t most substances & even oyster shells when calcined had this property, but it is the reason of this I do not know. Besides these there are several other other phosphori as the

Phosphorus of Baldwin.

150

Which is made by combining chalk wth the marine
x. & evaporating from the compound all its ϕ liba
bluish flame appears. it must then be kept in a vessel
hermetically sealed & on y^t account it has been called
hermetic Phosphorus, & shines after exposure to the day
light exactly like to the Bolognian Phosphorus.

There is also another that has been called the
phosphorus of Humberg this is another of these earthy
compounds, & is produced by mixing the ϕ wth Sal
Ammoniac & exposing it to heat & there remains be-
hind a substance w^{ch} does not shine in the dark but
that when struck by a hard body emits light from
it, but this light is manifestly Electrical, & common
lump sugar posesses this quality in a superior de-
gree, so that this does not come properly under
the head of phosphorus. Of all these phosphs
in the phosphorus of Humberg is the most elegant
wonderfull

The next of the solid inflammable bodies I am to consider
is

Sulphur

Which always is of a yellow or orange colour & is
either in a powdery form or in the form of cylindrical
rolls. There is no difference betwixt these two forms of
it only that the rolled kind is more impure than the
other & sometimes contains a little ϕ . Upon being
heated it melts into a redish coloured fluid. w^{ch} upon

being allowed to cool concretes into a mass the fibres of w^h deepseats earth other, & this needly texture is more evident if it be allowed to cool slowly. There is one remarkable circumstance of it that it is more fluid at its melting point than any other time, for if it be heated above this it becomes thick as tar tho' before it was as fluid as Δ . When thus rendered fluid it is fit for taking the most accurate impression from seals, and in this way it is much employed. One can frequently perceive its needly texture when combined wth other bodies as in Cinnabar &c. Its melting & vapourific point are very near one another for we find that as soon as it is melted it begins to sublime into flowers. During the sublimation it is performed in close vessels the air they contain separates some of the Δ from the Δ untill that it is entirely saturated therewith, after w^h the operation goes on without any farther decomposition. It is owing to this that the flowers of sulphur have generally a sour taste, but of this they may be deprived by washing them in water. They are said to turn sour on exposure to the air & so would seem to be capable of being decomposed in the common heat of the air but I do not find this to be the case, however as authors of very good credit do assert it I will not thoroughly deny it. It burns wth a blue flame giving less light than any substance that contains as much Δ . It would

seem to be wholly composed of the Δ as it burns without 181
leaving any ashes behind: but this is not the case as
is evident from the pungent smell that it emits, ow-
ing to the O flying off combined wth some of the Δ .

Many of the ancient chemists thought of various ways
of catching this vapour. Stahl proposed to do it by
dipping Rags in a solution of S & holding them over
its fumes. The salt obtained in this way is not a
true Nitriolated Tartar, containing in its composition
a quantity of the Δ , & tho' its crystals have the same
shape & dissolves also in V yet it may be decomp-
posed by any \times even the \times & the O thus obtained is
always combined wth the Δ ; & obtained in this way,
it is applicable to no purpose. In this state it differs
greatly from the pure O . The last heightens the
red colour of vegetables but the sulphureous \times decays
it altogether hence that trick of pulling a red rose
into a drawer & bringing it out white. This
 \times is of use in manufactures in whitening wool &
silk, as formerly mentioned, this whiteness however
is not very durable but may be restored by repeating
the process. It is not certain if it might be employ-
ed wth equal good effects in whitening linen; one objec-
tion to this is that thro' time it would be apt to be de-
composed & by acting on the linen render it less du-
rable. Sulphur has some of the properties of \times has

182-licularly apt of combining wth L° , & forming wth them compounds of a dark brown colour w^{ch} are generally known by the name of hepars from their liver like appearance. These are made by adding to F twice its weight of S & are used in experiments on metals: the S is here only proper; O are incapable from their nature. They may however be combined wth L° but they must be perfectly caustic else this is impossible. As therefore it must be in caustic form it is of advantage to bring it in contact wth the F as soon as it is deprived of its air, the ordinary process therefore is to take F , Sal Ammoniac & Quicklime to grind them together & expose them to heat in a retort, the F & S come over united & on opening the receiver a volatile cloud of white vapour arises from them w^{ch} is perfectly intolerable. Indeed all the hepars have a disagreeable smell but that formed by the S is the most nauseous of them all. When hepars are dissolved in O they communicate to it the smell of rotten eggs, w^{ch} however it loses upon boiling.

Earthy bodies may also be united wth sulphur & form compounds similar to those of L° . Thus if we take Quicklime it unites wth it & forms a hepar w^{ch} however is very perishable for upon exposure to the air the Sulphur & Quicklime are both thrown out of the water. The reason of w^{ch} is this as quicklime only is capable of uniting wth F on exposure to the air it attracts fix^d Air & becomes a C.D. , in con-

sequence of which, it & the Δ fall to the bottom. You can¹⁸³
not combine Magnesia or the Δ of Alum wth Δ by expo-
sure to heat in these vessels. But if we expose Charcoal
& Epsom salt to heat together a hepar will be formed
& the same also holds true wth regard to Alum. &
if we add a little ∇ to the pyrophorus of Shmberg it
will communicate to it the rotten egg smell of a hepar.

One Hepar may be decomposed by attracting fix^d air,
as also by a separation of the Δ . Quicklime
hepar can be decomposed by the addition of a δ
that is not caustic. For if it is caustic there will be
no decomposition. Any of the hepar may be de-
composed by the addition of an \times . the whole becomes
milky, & is then called Lac Sulphuris, the Δ falls to
the bottom. & a disagreeable smell arises, if to de-
compose a quicklime hepar the \odot is used the preci-
pitate is a mixture of Δ & Selenites

You know the effects of Δ on Neutral salts &
that they have none upon any but those that
contain the \odot . that with them it deflagrate & its
 \times uniting with their Δ forms a vitrified Tartar or
Glauber salt, according as we use Cubic or common \odot .
it may be converted into a hepar by exposing y^m
to heat mixed wth charcoal. In this state also it is
necessary to secure them from the air we would at-
tract the Δ , & the Δ attracting the \times there would
be a separation. Hepar thus produced are of

184 a beautiful deep red colour. We see then that Φ is capable of combining wth every species of Σ . with all the absorbent Γ 's when deprived of their air, but cannot unite with any other Γ . It unites with the Phosphorus of Huntel very readily & forms a substance possessing properties between the two, but it has not been applied to any purpose.

With regard to its origin: it is found in great abundance in the bowels of the earth & is perhaps the only inflammable substance we cannot trace to have been the produce of animal or vegetable matter. Tho it is found in great plenty yet it is seldom found pure, for the most part containing some σ mixed wth it, but when we do find it pure it is owing to its being refined by a process similar to what is used to purify it artificially, viz^t it has been sublimed by subterraneous fires & condensed in caverns, & accordingly it thus found near volcanos. Sometimes it is in the form of regular crystallized masses owing to its having been deposited from Σ wth contained it dissolved in the form of a liquor. It is found in very great quantities near volcanos & particularly in the neighbourhood of Vesuvius; in this state it has very little heterogeneous matter mixed wth it, & is called

Sulphur Vivum, w^{as} was formerly thought better
for medicinal purposes than the Δ . But it
differs from it only in containing a little earth.

From it all the Δ is obtained it being pure enough
for its purpose. We are supplied wth it from Italy
not that it cannot be got from any other place
for there is no quarter of the world except America
that is free of it, & indeed is found there which
would induce us to think that Δ likewise may
be obtained but this is not yet testified by any
account: it is also sometimes combined wth Φ & Ψ .

The only ore of Δ that contains it are the pyrites
& these can easily be distinguished by their brassy
appearance, & there are pieces of these among
most of our pit coal. There are some masses of
it grey externally that on being broke have that
brassy appearance. All the substances that have
this brassy appearance are not pyrites as for ex-
-ample these shining bodies in the common slate
the proper name of w^{ch} is the Marcasite, these
contain a mixture of Φ & Arsenic, but may be dis-
tinguished from the Δ pyrites by their greater
hardness, & striking fire wth steel.

The materials from w^{ch} the Δ is to be extracted

is put into an oven w^{ch} communicates wth a chamber into w^{ch} the ϕ sublimes this chamber communicates wth a second into w^{ch} it is carried by the increase of the heat, but as part of it remains in the first it is mixed with some heterogeneous matter by melting & running down, & is collected after the operation, melted in ϕ pots & cast into ϕ cylinders while the flowers in the 2^d chamber as washed & sell dearer than the other kind. - The next inflammable substance is the

Charcoal of Wood

Which every body knows is wood half consumed by burning, & smothered up in that manner till it goes out. It yields by burning only a small quantity of ashes & four ounces of it yield only a few grains of ϕ , but the same quantity of wood yields a considerable quantity of ashes $\frac{1}{4}$ or at least $\frac{1}{10}$ part of w^{ch} is ϕ . As it leaves behind it few ashes it is the most proper species of fuel for chemical operations, but as it yields a great quantity of f^{et} air w^{ch} is very noxious, it is on y^t account the worst species of fuel for furnaces w^{ch} cannot draw

well, and this matter ought to be particularly attended to. It differs from all other inflammable bodies in being unchangeable by mixture wth any body below a red heat. & is of itself perfectly fixed wthout addition. It is principally employed in conveying the Δ to bodies the Δ of w^{ch} it contains a great deal, & because its inflammable part is elastic & escapes during the operation. & tho a purer substance than charcoal is not so proper for conveying the Δ to bodies as is evident from the difference between the substances left after the deflagration of Sal Nitre by these two bodies. If it is added to Epsom Salt & the mixture exposed to heat in close vessels a decomposition takes place & we get a volatile sulphureous Δ . These are the principal circumstances I have to mention wth regard to this substance w^{ch} I have described under the title of the charcoal of wood, but there are other charcoals that have the same properties as for examples those obtained from oils.

We come next to the fluid inflammable bodies w^{ch} are of two kinds viz ardent spirits & oils. The first of w^{ch} are miscible wth the inflammable, & the 2^d are inflammable but immiscible wth this fluid.

Ardent Spirits.

Is a singular substance being inflammable & also miscible with water in any proportions. It is entirely an artificial production & is generated from vegetable substances by fermentation; the vegetables that ferment & yield it best are those of the sweet kind; but all substances that are inflammable & capable of solution in water, may be fermented. It will therefore be necessary first to consider Fermentation. In all the states of fermentation some of the component parts of the body are separated, & combined together in a manner different from what they were formerly, & the degree of this alteration is according to the length of time the process may have been continued. There are three kinds of fermentation the Vinous the Acetous & the Putrefactive. During all these three the appearances are nearly similar but their products are different, some bodies are capable of one or more of these fermentations. The Acetous always follows the vinous fermentation, but

is not necessarily preceded by it. The product 180
of the first joints of ^{fermentation} putrefaction is spirits, of
the 2^d Vinegar, & the 3^d except aerial mat-
ter yields only a minute proportion of L .
To stop ~~putrefaction~~ ^{fermentation} it is necessary to remove
the materials into clean vessels & w^h must be
kept cool. That bodies ferment it is necessary
that they be diluted wth a sufficient quantity
of water, be exposed to a sufficient degree of heat
& also that they be exposed to the air. Hence
animal substances may be kept in cold coun-
tries without any antiseptic being added: also
bodies that are diluted wth V & are apt to fer-
ment may be kept from it by evaporating
away this V , as is often done wth the juices
of fruits & flowers when they are converted in
to a Rob, or extract: & animal substances
may be kept for any length of time in the
exhausted receiver of an air pump. During life
fermentation is carried on in the human body &
in some diseases. putrefaction may be very distinc-
tly perceived. The great promoters of ^{fermentation} ~~putrefaction~~ are
heat, a sufficient quantity of water, & the addition

of some body that is in the state of fermentation
 Thus if the scum y^t rises on the surface of a bo-
 dy ^{in the Vinous} ~~capable~~ of fermentation be added to one capa-
 ble of fermentation it will raise in it the Vinous
 fermentation; & if a part of a body in a putre-
 factive state be added to a substance capable of
 fermentation, it will raise in it the vinous, but then
 it will go on very Violently & soon turn to the ac-
 -tous, & if care is not taken will run into the
 putrefactive. Hence bodies ferment best when
 no stream of air is allowed to pass over them, so
 that there shall be always in contact with the
 steams y^t arise from them & w^h when not dissi-
 -pated by a stream of fresh air, hover around them.
 It has been said that ^{as} matter in the vinous state
 of fermentation, when added to matter capable
 of fermentation raises in it the vinous fermenta-
 -tion y^t matter of the putrid kind being added
 raises immediately the putrid fermentation but
 it only raises the vinous fermentation in a more
 violent Degree. & in this case it is not so easy
 to be stopped. Substances in themselves incapa-
 -ble of the vinous or acetous fermentations may
 be made so by addition of substances capable of

These. Thus flesh may be made to undergo the vi¹⁹⁴
nous fermentation by the addition of sweet sub-
stances, or of the acetous by the addition of bread.
The flesh of young animals may be made to un-
dergo the acetous fermentation without additions.
Vegetables of a saccharine taste may be made to
pass thro these 3 stages most perfectly, & also may
be made to pass over the vinous stage by the heat
applied & the quantity or quality of the ferment
added. The Vinous & acetous fermentations are
the only ones that are ever raised willingly, the
putref is never designedly raised but in the ope-
ration of obtaining Nitre. Whatever mat-
ter any substance contains, before fermentation
they always contain part of this after being con-
verted into ardent spirits, & the purer the sub-
stance before fermentation, the purer are the spi-
rits obtained from it, & of all substances that yield
it sugar is the purest, but it still contains
mixed with it some slimy matter. That obtain-
ed from the juice of fruits as apples, pears,
plums, peaches, currants raisins gooseberries
&c, as they before fermentation have a portion

of acid mixed with them, the various liquors obtained from them have always a little of this in their composition. When malt liquor is fermented it requires a moderate degree of heat & it is owing to this that warm climates produce good malt liquors. When the vinous fermentation has gone far enough, then it is necessary to stop it otherwise it will run into the acetous, & for this purpose, some antiseptic substance is added, & the bitter substance of the hops answers this exceedingly well, ^{as also Gallap & Spicaguan.} & it is also necessary to diminish the heat. Sometimes O_2 is added for this purpose when it is intended to make ales of great durability, & in some of these the taste of the salt is very evident, we can even get it by evaporating a small portion of the liquor. During the fermentation an \times matter is often produced before the vinous fermentation has ceased owing to some part of the grain being more apt to ferment than the rest, so as to become \times before the other

has been fermented into a vinous state, it will on y^r 193
account be necessary immediately to check the ope-
ration to remove the whole into clean vessels &
to remove them into a cool place, or to fumigate
the vessels previously wth volatile sulphureous &
w^{ch} checks the fermentation in a wonderful man-
ner. Besides it will be necessary that the grain
be all of the same years growth otherwise it
will ferment unequally. A quantity of the
colouring matter of the fruits especially of grapes
remains & tinges the various liquors, & it is a
practice to change their colour naturally clear
by boiling in them some of the husks of the
grapes. Where the grapes grow that have no
colouring matter, the wines are made red by
adding some plant as Archil, & these wines
part more easily with their colour than others as
is the case with the Portuguese wines.

During the fermentation the quantity of fixt
air that separates is very great, and it ought
to be carefully avoided as it sometimes produces
very fatal effects. The purest fermentable

substances ferment very easily at 70° or 75° of Fahrenheit's Thermometer; but sometimes the heat is necessarily greater than this from the temperature of the climate; & to regulate this it is absolutely necessary to have a Thermometer.

The vinous substance obtained by fermentation differs from the sweet matter 1^{st} yields it, in being more inflammable, & also in its being intoxicating which the sweet substance is not. Sweet bodies of themselves are antiseptic but by diluting them with a sufficient quantity of V. & exposing them to heat the process of fermentation is begun. When this goes on hastily it yields a greater quantity of ardent Spirit, but renders the taste of the other matter not so agreeable; hence when fermentation is raised with a view of obtaining only the spirit, it is afterwards to be distilled off, then the operation is hastily performed. But when the other matter is also to be used then it is necessary to use more nicely & that the fermentation go on gradually. When a sweet substance is diluted with water in order to make it ferment, if it is first made to boil the fermentation goes on more gradually & ~~this method is used~~ hence they boil

their malt liquor before they set it to ferment. If 195
we throw into a vessel of liquor just beginning to
ferment, a pint of warm boiling & at a view of
hastening the fermentation, it passes over the vi-
nous altogether & runs into the acclous fermentation.
The water poured on therefore should never be above
90°. The gentler the heat employed to dry the
malt the clearer is the liquor obtained from it, &
when they want them very pale they dry the
malt in the sun; the colour differs also ac-
cording to the species of fuel made use of whe-
ther it has been wood pit coal &c.

The art of separating the spirituous part
of the wine seems to be wholly a modern inven-
-tion, the antient Greeks & Romans were ac-
-quainted with the method of making wines but
none of them knew the principle how to sepa-
-rate from it that part to w^{ch} it owes its valu-
-ed qualities. By wine I mean every sweet fer-
mented substance. The Arabians were the
the first that used Distillation, & they knew
the method of separating this substance.
The Alchemists also were well acquainted
with it. Tho it may be obtained by a

very clumsy method of operation yet it requires to get in sufficient quantity & purity very gradually. The purity depends on the heat being as gentle wherewith it is distilled as possible; one would be ready to think there would be little danger of the waters being heated above 212° , but that portion nearest the bottom & sides of the alembic are very apt to burn if the heat is raised too hastily or to too strong a degree. Therefore it will be best to proceed with a very moderate fire, & the distillation goes on best when we can scarce perceive any interval between the drops; this however is not practised by those who follow distilling as a trade, as it would take up too much of their time, but wherever it can be done conveniently the purity of the spirit will indemnify the operator. If the vapour does not escape readily it will rarify & occasion a pressure on the surface of the materials so as to make it endure a strong heat without boiling, hence this ought to be avoided by keeping the refrigeratory vein as cool as possible. We must also separate the 1st 2^d & 3^d runnings from one another, as

They differ much in regard to purity from one another. The 1st is impure on account of the frothy swelling of the materials before boiling, so that some impurities unavoidably come over but this portion is ⁱⁿ very small quantity, & is not so disagreeable ~~from~~ as the 3^d or last running is small & taste very strongly of the fire, & ought to be kept from the 2^d or intermediate runnings carefully as it is ^{the} ~~the~~ purest part of the spirit. One circumstance ^{is} the cause of the last ^{running} having a burnt taste &c. is that the most spirituous part is raised in the beginning so that the part which remains being more aqueous boils at a greater degree of heat. The only method to remove this empyreumatic taste is to expose the liquor to a degree of cold below the freezing point, & this has succeeded at me perfectly on distilled simple waters, & in one or two experiments on spirits. As to the quantity of the spirits, the purest fermentable substances will yield a 5th part of spirits if properly managed others will not yield above a 50th part, & this varies exceedingly according to the way the operation is conducted, both in the fermentation & distillation & during the last not one particle should escape

we may be prevented by keeping the refrigeratory per-
 fectly cool. The different Spirits are either prepared
 from Sugar, grapes, a species of palm tree or malt. That
 got from sugar is rum. the produce of grapes is brandy.
 That of the species of palm tree ^{if} grows in the East Indies
 is arrack & if of malt is Whisky w^h is the most im-
 pure of all, rum being purer than any. In Sweden
 they prepare a spirit by fermenting potatoes, & in some
 places they use parsnips. Besides the ψ there is
 a portion of oil elevated along wth them in the de-
 cation, w^h it becomes necessary to separate when we
 intend these spirits for chemical purposes. It
 is generally known that all spirits become more
 agreeable by age, now this is said to happen by a dis-
 sipation of this oil or as I would be more disposed to
 believe by a more perfect union of it & the spirits.
 All of them may be freed of this oil by distilling
 them again from ψ , & if this be repeated a 2^d or
 3^d time they become almost perfectly pure so as w^h
 none of them can be distinguished w^h kind they belong
 but they will need to be often distilled according
 as they are whiskey Arrack brandy or rum w^h is the
 purest & therefore does not require to be so often
 distilled as any of the rest.

When ^{Spirits} they are distilled they always contain a proportion of σ blended wth them, w^h however varies at different times of the operation: that w^h comes over first & on that account called first shot contains about $\frac{1}{4}$ or $\frac{1}{3}$ its weight of σ ; as the process advances it becomes of $\frac{1}{20}$ part of σ to 10 Spirits. This σ may be separated by rectification in part, but after all it always retains of water $\frac{1}{8}$ part. The only method of rectifying it is to have recourse to a Chemical electric attraction, by adding something w^h will attract its σ more strongly than it is attracted by the spirit. One of these is Salt of Γ viz the δ obtained in burning Γ w^h if it is added to a quantity of spirit attracts its σ & forms a distinct fluid w^h falls to the bottom of the vessel. Then we employ the δ for this purpose it ought to be perfectly dry, & in the proportion of γ viii to γ lxxii of the spirit. In this case the spirit dissolves a small portion of the δ so that it acquires a yellowish tinge. This - may be separated by filtering the whole to hind. & distilling it w^h the spirit will come over perfectly pure & in that state is called Alcohol, this however still

of v. With regard to the effects of mixture upon it, it attracts & more strongly than any of the Neutral salts, hence it has been proposed to add it to a solution of them to promote crystallization. There have been several methods proposed to ascertain whether it is strong or weak. The 1st of these is to shake it and to observe how long the bubbles continue on its surface, the longer they continue the stronger is the spirit, but this is fallacious yet it may be made to appear stronger than it really is by the addition of a little sugar. A 2^d way is to pour upon it a quantity of olive oil & to observe if it sinks in it or swims on its surface; this method is also uncertain. Another method is to use a Hydrometer w^{ch} is an instrument something like a Thermometer wth a scale marked upon it, this is put into the spirit & the deeper it sinks the stronger is the spirit & vice versa; this is a tolerably good way but it is apt to alter by heat hence the spirit will appear stronger in Summer than in winter. Another method is to use the Hydrostatics balance, where the odds of the weight of a ball

in the air ^{is} as the weight of the spirit of wine but by all Hydrostatic balances the spirit appears weaker than it really is. The best method is to adjust glass balls that they shall sink or swim in a spirit of a given strength, thus it is proper to have a number of them ^{each of which} ~~all~~ adjusted to a spirit of a certain strength. When we want to know the strength of any spirit we have nothing to do but to throw them into it & those that were adjusted to a quantity of spirit weaker than that we are examining will sink to the bottom, while those that were adjusted to a spirit stronger than it, will swim on the surface, & if any of them have been adjusted to a spirit exactly similar it will remain in whatever part of the vessel it is put. This is the temperature ^{being} ~~being~~ ^{adjusted by the} ~~adjusted by the~~ ^{thermometer} an invention of Dr Wilson's. & is the best method of ascertaining the strength of spirits. Another way ~~is~~ to know if a spirit is of the strength of Alcohol is to pour a little of it on some gun powder & to inflame it, & if it sets the powder on fire it is a mark of its strength. Another method is to wet a little cotton & to observe if it sets it on fire; but all these methods are faulty & the

203

method w^e can be best relied on is w^t of using the glass
balls. I use Alcohol & spirit of wine as synonymous
terms, tho spirit of wine is used to signify it when
partly deprived of its ϕ , & when diluted w^t half its
weight of it, is called proof spirit, w^e is better fitted
for dissolving some substances than the spirit a-
lone, accordingly it is often ordered in Dispensatories
under the title of French brandy. When we use an
 α to attract from spirits the ϕ they contain, that
is saturated w^t air it does not produce the ef-
fect desired, but if it be perfectly caustic it dis-
solves in the spirit of wine as well as in ϕ there-
fore it ought to be used in the intermediate state
when it is half saturated w^t air, & it is best for
this purpose when just obtained from Potash. If
spirit of wine is distilled for a number of times
from a ~~caustic~~ it is wholly changed, as was long
ago found out by Van Helmont & B. Boerhaave.
By this process the spirit is wholly decomposed, the
being converted into an oil ϕ , & χ w^t uniting w^t.
tho it forms a regenerated ϕ , & this succeeds best
when the ϕ is caustic, & not in the ordinary form
as it was employed by Van Helmont & B. Boerhaave.

Vinegar ∇ & Δ then are the component parts of this fluid the \times being the medium whereby the Δ is united wth the ∇ , hence we would think we could obtain these from it by burning it, we do indeed get from it heat & light the signs of its containing the Δ & we get also ∇ , but no \times as this is perfectly destroyed by a red heat: the \times is therefore not produced during the process but is the medium whereby the two substances the ∇ & Δ are combined.

When we distill spirit of wine from a \times it still retains a little of it in its composition as is evident by its burning milky or adding to it the ϕ whereby it becomes milky, & to separate this ϕ it is the most proper method to add some Epson salt the ϕ of it will attract the ϕ & both the Magnesia & the vitriolated ϕ will fall to the bottom together. Spirit of wine also unites wth the δ & forms a very volatile fragrant substance, called Spiritus Salis Ammoniaci Dulcis, wth when combined wth some fragrant oil is called Eau De Luxe. But tho the caustic δ does not the mild δ does not, on the contrary if some spirit of wine is added to

205

a solution of mild S it attracts the V & the S is immediately thrown out of it. Van Helmont was very fond of this experiment & called it the *Effa Helmonti* but what he meant by this I do not know.

I shall next mention the effects of S on this substance & shall take these in their common order in S they stand & first the O . It has a strong attraction for the water & inflammable parts of Alcohol; if we pour a quantity of O upon some spirit of wine highly concentrated it falls to the bottom, wth a hissing noise, some degree of commotion & a peculiar fragrant smell; & at the same time a degree of heat is raised, w^{ch} is the greater, the more water the spirit contained. The proportions are equal weights of O & Alcohol or w^{ch} comes to the same thing, two measures of Alcohol & one of O . After the hissing noise & vapours have ceased, tho before the liquor was colourless it becomes yellowish or of a reddish taint this depends upon the kind of spirit used, if it contain much oil the deeper will be the colour, but if it has been purified in the manner I mentioned to you the colour is not altered. Also if we use common

For this purpose the liquor will become muddy, and will deposite a sediment owing to its dissolving a small quantity of it from the vessels in which it is prepared, & which may be separated from it by distilling it, but the common \times is sufficiently pure for this process. If I take the liquor after the Oth has united with the spirit & digest it in the a degree of heat equal to that of the human body for some days a fragrant liquor will be produced which is called Rabels water; but if instead of this if I put it in a retort lute on a receiver & place the retort in a sand bath, there will first come over a highly rectified spirit of wine we have escaped the action of the Oth , by and by drops will begin to appear in the neck of the retort, & then the fluid that distills is not spirit of wine but ether, after these little drops or points have all trickled down into the receiver, & no more begin to appear wise than unlute your receiver, & if you perceive vapours that have the smell of burning brimstone then lute to a fresh receiver & continue the distillation there will come over an acid substance that smells stinky of burning & then a thick oil &

207

There will remain in the retort a black larvy matter
w^{ch} if is uncautionously heated is very apt to run over
into the receiver & burst the vessels, but if a regu-
lar heat is applied, a quantity of a true ϕ comes
over. & there remains a charcoal in the retort.
but if we add ψ to the larvy matter before we destill
it the whole will come over & will have the pun-
gent smell of the volatile Acous ϕ . It is common
to stop the Destillation whenever the fumes of the
volatile sulphureous ψ can be perceived; & if we add
to 1bii of Alcohol the same quantity of ϕ &
destill we will get from it ζ ss of fluid one half
of which is a strongly rectified Spirit of wine, the
other is the Ether of Probenius as it is sometimes called
which is the substance that is most valued. & these
may separated by a second destillation, the common
way was to mix with the ζ ss of liquor a solution of
& when upon shaking them the Ether immediate-
ly floats distinct, & may be drawn off wth a sy-
phon, but this is inconvenient as some of the
 ψ is apt to mix with the ^{Ether} water or some of

the Ether with the ψ . So it will be most proper after adding the solution of the δ to distill the Ether by w^h means we will get it quite pure. Ether in this state is perfectly limpid. is the most expansible & the lightest of all bodies its expansion is to that of alcohol being as $7\frac{1}{2}$ to $6\frac{1}{2}$. It is also the most volatile of all bodies except the caustic δ ; it boils at 100 in the open air when the barometer stands at 30 inches; & if you take the pressure of the air from off its surface, by putting it into the exhausted receiver of an air pump it will boil at the temperature of 12 degrees below 0 in Fahrenheit's scale. & the cold occasioned by the evaporation during this process is very great, even when it evaporates in the open air it produces a very considerable degree of cold as is evident when we put a little of it on the finger & expose it to the air. From its volatility it is difficult to keep it so that it requires to be kept below the surface of ψ . If I pour a little of it into a bottle it will rise in the form of vapour & fill it so as to exclude the air, & if I incline the mouth of the bottle near a candle, it rushes out & takes fire producing a pretty smart explosion. Its volatility may also be shown thus if we throw into water heated a good deal below

its below its boiling point a piece of matter that is 10, 20
rare moistened with ether for example a bit of sugar a
great commotion will be produced, & the ether escaping through
the water will give it the appearance of boiling. It is
^{used} given in medicine, & given chiefly in spasmodic com-
plaints, & it is said to have cured moderate headaches, for
these purposes it is both taken internally & applied ex-
ternally. The process I have mentioned was first pub-
ly described in 1730 by Probenius but since his
time there have been considerable improvements found
out. One principal circumstance is to obtain as great
a quantity of ether as possible from a given portion of
spirit of wine. Thus it has been discovered that
if we add a fresh quantity of spirit to the matter
that remains & treat it just as we would do so much
of spirit of wine, we will get a much larger quan-
tity of ether than the first time we distilled. Thus
for example, after having distilled from lbij of the
mixture of spirit of wine & 5 1/2 of liquor, if we add
to it lbij more of alcohol and distill till sulphureous
fumes appear in the receiver, then add lbij more
& distill again & repeat this over a 3 4 & 5
time we will get more ^{ether} at the first than formerly

more at the 2^d than at the 1st, more at the 3^d than at the second & as much at the 4th & 5th times as at the 3^d. This was discovered by M Cadet a French Chemist, but his theory has not been universally received as it runs counter to that theory concerning Ether mentioned by M Macquer & universally received by all the philosophers in France. I have examined into this theory of M Cadet, & find that it agrees perfectly with all my experiments; it indeed seems strange that M Macquer should dispute & attack this theory without trying the truth of it by experiments. M Macquer's theory concerning Ether is that the ϕ by attracting from the spirit of wine etc ψ , it is obliged to come over combined wth as little ψ as possibly it can, in consequence of w^{ch} it appears in the form of an oil. Now the ϕ if this were true could only do this to a certain degree, & when it should be saturated wth the ψ of the spirit it would be absurd to add to it, more alcohol wth a view of obtaining from it a fresh quantity of Ether; but this is contrary to experiment, & the theory of M Macquer is void of foundation; for Ether can be proved to consist of other substances than those w^{ch} compose spirit of wine: Ether is composed of the Δ united with

211

by the medium of the Ot, it constitutes the difference be-
twixt it & spirit of wine, for I can get Ot from it by bur-
ning it, but not by distillation from caustic L^{ne} & alto-
gether proves it to be quite a different & new substance

I shall next mention the effects of the Ot on alcohol
It has not so strong an attraction for it as the ϕ but
it has a stronger one for the Δ . In the former case
the spirit of wine may be poured on the Ot or the Ot on
the spirit, but if in this case the spirit is poured on
the Ot the whole escapes in the form of nitrous air
the ϕ is left behind being decomposed by the Ot
it unites wth the Δ . But when you pour the Ot
on the alcohol, the case is different; if 1 part of ϕ is
poured to ³ of alcohol, there ~~is~~ ^{are} effervescence & fumes
arise, attended wth a particularly agreeable smell
& this when distilled is the sweet spirit of nitre
this compound yields no ether. After the distil-
lation there remains a quantity of ϕ . Mr. Sa-
vier however discovered a method whereby an ether
may be made by Ot & alcohol to take $\frac{1}{2}$ of high
ly rectified spirit of wine, pour it into a glass
vessel placed among ~~ice~~ ^{ice or} snow, then add to it
 $\frac{1}{2}$ of Ot & let it stand for 24 hours when

212 a yellowish substance will gather on its surface
w^h is ether, & if it be allowed to stand for some time
longer more will gather on its surface till the
quantity amounts to about 1/3iv. During this time
there is a great quantity of elastic matter separated
so that, if we take out the cork always to allow it
escape we will lose a great part of the ether, it
will therefore be advisable to pierce the cork wth a
small hole to avoid this inconvenience. This is the
method of making the pure ether according to M^r
Kavir & which all the French chymists practise.

I shall shew you a 3^d Method of adding the Ot
to Spirit of wine, & one whereby there is no danger
as the two do not come immediately in contact
but approach one another thro' the medium of ψ .
Pour into a bottle 1 part by measure of Ot then
pour upon it slowly at the same time inclining
the glass an equal bulk of ψ so as it may float
on the surface of the Ot. Then pour on its surface
two parts of spirit of wine by measure, so as wth
all the three fluids shall float separately & dis-
tinctly; then cork up the bottle & let it stand

for some days without touching it. The \times will begin to^{27/3}
attract the Δ & then at that part they will become
green, the alcohol also will attract & be attracted by
the water, when the \times & spirit come in contact they
will become blue, & in 2 or 3 days they will become
muddy & an intestine motion will arise among the
parts of the fluid, & there will arise to the top a ci-
tron coloured fluid. This substance has ~~the~~
properties very similar to those of the nitro-
lic ether, it contains more \times & therefore will
require the addition of a δ to attract it. It is
rather more volatile than the nitric ether &
more inflammable, but it is not so pure as it
burns suddenly wth a smoke & leaves a charcoal
behind. The smell of this ether is exactly
like that of fine ripe apples as all the pre-
parations of alcohol & the Ot in some measure have.

We can obtain nitrous ether by dropping Ot into the
nitric ether w^{ch} confirms my opinion that the nit-
ric ether is composed of the Δ united to ∇ by means of the Ot
& as the Ot has a stronger attraction for Δ it upon being
added causes that decomposition, & uniting wth the Δ & ∇
forms nitrous ether.

We come next to the effects of the O_t on Alcohol.

It has very little attraction for any thing inflammable & a weaker attraction for v than any of the other O_t of oils acids. Upon dropping it into Spirit of wine it in some measure combines wth it & forms *Spiritus Salis Dulcis*, but this partakes so much of the nature of both ingredients as scarce to deserve the name. M^m & W^m Woodse shewed that

the O_t might be combined wth alcohol by making the fumes of the two substances come together from 2 retorts into one common receiver. The Marquis of shew ed a very easy method of making this Ether, to combine the O_t wth tin, & then add the alcohol to it & proceed to destillation, and an Ethereal fluid will come over. This Ether very much resembles that of the O_t , but it has no peculiar characteristics, except that it remains transparent tho' kept for a considerable time whereas the O_t Ether acquires a yellow cast.

It may also be obtained by adding to the compound of O_t & zinc a quantity of spirit of wine & proceeding to destillation —

Even the \times is much much weaker than the Josph ²¹⁵
-sile \times , yields a greater quantity of Ether than any
of them. The process is nearly similar to that
for the Ole Ether. viz to add the strong \times to alcohol
& distill. This Ether has always a strong
smell of vinegar, & like the Ours Ether often con-
tains too much \times - it is therefore necessary to
add to it Ol Tart & Deliquium & distill a 2^o
- time: it is not very durable as it loses its
transparency & becomes yellow in the space of
a year.

These four are ^{all} the ethers that have hitherto
been made it is not improbable but ^{it}
that there might others be made but none have
as yet been found out. The Tartarous \times has no ef-
fect on Spirit of wine, The Reductive salt dissolves
in it & burns wth a beautiful green flame when
set fire to: The Neutral salts formed by Josphile
 \times & R. do not dissolve in alcohol & if it is
added to a solution of them in ∇ , they are pre-
cipitated: the compound salts formed by the \times
& R. mostly dissolve in it. The Tartarum rege

generatum seems to a very proper substance to
 Distill it from when we rectify alcohol as it at-
 tracts & more strongly than any of the simple
 salts, & there is no danger of the spirit being
 altered by it as its α is saturated wth the α . it
 is the basis of the spirit. All the compound
 & simple salts have no disposition to unite wth alcohol
 & acids are all insoluble in it. The compound
 of the Cl & the P & S dissolves however in it &
 on account of its attraction for V is employed
 to rectify it. Inflammable bodies have little
 effect on it, it dissolves in phosphorus &
 Phosphorus & extracts from the pyrophorus of
 Nöberg its inflammable part.

These are the principal observations wth
 regard to Spirits. I come then to the second
 class of the fluid inflammable bodies viz.

Oils.

They are divided into two classes the Aro-
 matic & Unctuous oils; these have no other
 distinction but what their name imports, the

first have a strong aromatic smell. The second are known by their having no smell & by their un-
 usually being employed to lessen friction in ma-
 chines. Aromatic oils are all of vegetable origin ex-
 cept three kinds w^h are obtained from animal substances viz
 castor, musk & civet. These yield only a small quantity. The
 Unctuous oils are common both to animal & vegetable sub-
 stances. They are secreted in the plants during their
 growth & deposited in bags. The oil is secreted at dif-
 ferent periods, sometimes in early infancy of the plant
 & is in greatest quantity when the seeds are
 formed. Sometimes it is contained in the seeds or
 fruits of the plant & then it is found no where
 else.

Aromatic Oils

Or Essential oils as they are also called, because it is
 to them that the plants owe their odour fragrance, they
 differ from one another in smell, acrimony, consis-
 tence & volatility. No two of them resemble each o-
 ther in point of odour, & they all differ greatly in con-
 sistence; when exposed to the air they lose in a great
 measure their smell, & become thick without losing
 in their weight & are then called Resins; the

time wherein they undergo this change is different in all of them, & by this change they acquire some colour tho' before they were transparent. As they lose their smell & fluidity at the same time it was supposed that this was owing to the flying off of one common principle, ^{on} w^{ch} the fragrance & fluidity of the oil depended, & on that account was called the *Spiritus Rector*. It is surprising how they lose this not only on exposure to the air but ~~even~~ if they are kept in a vessel hermetically sealed, thus Oil of turpentine kept in this manner becomes thick & of a brown colour & we will find it to have lost much of its smell. I am disposed to think this change happens in consequence of a new combination of the component parts of the oil & not the flying off of a *Spiritus Rector*.

We can form no notion how much oil a plant will yield according to its fragrance as those w^{ch} are very fragrant yield exceedingly little some times, & sometimes others endowed wth very little fragrance yield a considerable quantity. Thus the

one would think that roses should afford a considerable deal of oil, but they afford very little; Also the March Violet on account of its agreeable & extremely diffusible smell might be thought to contain much of essential oil, but the fact is none can be got from it.

These oils are not produced by chemical operations but existed before ready formed in the vegetable & some of them can be obtained by expression, as is of the rind of Lemons. All of them when pure are volatile in the heat of boiling water but if they have become thick by exposure to the air they will not rise by any heat. It is in consequence of the volatility of aromatic oils that any adulteration of them with unctuous oils is easily discovered all we have to do is to drop a drop on a piece of paper, it will make the paper greasy as unctuous oils do, but upon holding it near the fire, tho' not so near as to scorch the paper, it will fly away & the paper will become perfectly clean. This property of Essential oils is of use when we intend to draw upon a piece of paper any picture by placing it above another, when the oil on being laid on makes the paper transparent so that the

picture shines thro' & we can free of the oil afterwards by heating it a little. Essential oils every time they are distilled become thinner & purer & leave always a residuum behind them, also a little Δ & $*$ is found in the retort, so that the Δ & the $*$ are two of the component parts, & the only difference betwixt them & Ardent Spirits is that oils consist of the Δ ∇ & the $*$ united together wth the intermixture of some earth w^{ch} the spirits want: & we can obtain $*$ from them by distillation tho we can get none by burning them as it is totally destroyed by a red heat.

Every time the different oils are distilled they always approach nearer and nearer to one another in likeness, & become more & more miscible with water, & here I join with Mr Macquer in his theory that by repeatedly Arcaling them in this manner they may be changed at last into Alcohol, as by this method the earth which the oils contain in their composition, and w^{ch} constitutes the difference betwixt them & Ardent Spirits is separated. These experiments are very unfavourable to the doctrines of the elder Chymists. Macquer thought that Essential oils contained an acid superficially united wth them, and this theory is also very probable, as they change the colour of the cork wherewith they are stopp'd to a yellow

hue, and change the blue test paper red when suspended for a certain time over them, and even render it acrid, converting them into a regenerated tartare

Essential oils are not miscible with ∇ in any proportion, but a little of them w^{ch} is the most fragrant part dissolves in that fluid. This combination is frequently prepared for medicinal purposes and goes by the name of the simple distilled ∇ of the plant.

The method of preparing these waters is to put into an Alembic the plant gathered when in its utmost perfection w^{ch} can only be known by experience, then to pour on it as much ∇ as will fill two thirds of the vessel, then to lute on its head and proceed to destill as long as the water comes off impregnated with the odour of the plant; those waters that are destilled from the fresh plant are the most agreeable. It may be farther observed that the part which destills first is more pleasant than that which comes over last w^{ch} is generally empyreumatic, and disagreeable. But this upon being kept for some time turns gradually more pleasant & upon being exposed to a degree of cold sufficient to freeze it, it turns as agreeable as that w^{ch} came over at the beginning of the distillation. If we want to get the Essential oil of a plant it will be preferable to dry it previous to the distillation, for as plants when newly gathered are full of moisture, in them the oily particles are more diffused and separated by the interposition of the aqueous parts; so that in distillation they ascend in a state of separation, and cannot unite together but in small quantities, and are therefore with difficulty separated from the waters.

But in the dried plant. the oily particles being freed from the intervening aqueous parts that kept them separated from one another, they unite and form little globules of oil w^{ch} can easily be separated from the & used in distillations. In drying these plants great care must be taken not too expose them to too strong a heat least their odour or part of their essential oil be forced off.

As Essential oils are volatile in the heat of boiling water the redundant part besides that w^{ch} unites with the water arises in distillation and either swims on the surface or falls to the bottom of the water according to its density. It may be separated from the water in three ways. 1st By filtration. 2^{dly} By draining it off with a cotton thread in the manner of a siphone. or 3^{dly} By means of the



in the following mannere. We stop the lower opening of the vessel A with our finger and then pour in the water and oil together. Then holding the end A over a proper vessel we remove our finger and allow the oil or & to run out according to their situation, suppose that it is the water lies at the bottom we allow it to run out first and when the last of it has run out & the oil is just approaching, we with our finger immediately stop again the opening A, and afterwards pour the oil into a vessel by itself. This vessel is generally made of crystal.

If we want to know how much oil a given quantity of any plant will yield we must for a very obvious reason use Γ already saturated with the essential oil of that plant to distil from it. It has been recommended to add some common salt to the Γ with a view of preventing putrefaction during the time it is infusing previous to the distillation, but as this addition enables the water to bear a stronger degree of heat without boiling and thereby to give the distilled Γ an empyreumatic flavour, this addition will therefore be unnecessary, especially as there is no danger of putrefaction, as one forenoon's infusion is long enough for the hardest woods if they are properly comminuted.

The O acts very strongly on essential oils, and darkens their colour while it renders them thick at the same time. The O acts very violently on them and inflames some of them, & the O changes their colour & consistence as the O does. Fossile acids make them very similar to bitumens and on that account it has been thought that these are formed by the union of oils and acids in the bowels of the earth. Alkaline salts have little disposition to combine wth aromatic oils: much time was employed by Starkey in a pursuit of this kind; it is now well known that no α will ~~become~~ unite with an oil, that has not become thick by exposure to the air; but after all the compound thus produced is of no value. The caustic volatile alkali unites with aromatic oils and forms a compound which

44
dissolves in spirit of wine and is then called Eau De Suceur
is a very fragrant solution. As this solution is not tran-
sferant but milky it shows that the S & Aromatic oil have
not entered into a true Chemical union. Compound salts
and Earths have no effect on Aromatic oils. Of the
inflammable bodies the Phosphorus of Frankel dis-
solves in them; also Δ unites with them and these compo-
sitions are called Balsams of Δ . It is here preferable
to boil the Δ first in a quantity of Unctuous Oil so as
to dissolve it, & afterwards to add the Aromatic Oils.
Whatever virtue these compositions may possess, they
are very disagreeable Medicines.

Aromatic oils & resins &c. dissolve very readily in Spirit of
wine, & this is one of their characteristic properties; but they
dissolve in it with different facility; some of them will dis-
solve in any proportion, others only in small quantity. Spi-
rit of wine impregnated with resinous parts is much used in
varnishing, but its ingredients do not adhere very strongly, as
they may be separated by adding ∇ which attracts the Spirit
while the resin is set at liberty. Spirits when distilled from
a plant containing an aromatic oil come off impregnated
with their odour, and are used in medicine under the name
of Spirituous distilled waters. It may also be observed that
by infusing plants in Spirit of wine their essential oil is extrac-
ted from them and dissolves in that menstruum, a compo-
sition of this kind is called a tincture its ingredients may

likewise be separated by the addition of ψ . If we evaporate this composition we indeed obtain the resinous parts of the vegetable but in an impure state as the Spirit of wine also takes up some of the saponaceous juices of the vegetable. Resins flow from the plant in which they are formed at a certain season of the year, either from an incision made with a knife, or from the pores of the vegetable. The fir tree yields a considerable quantity of Turpentine; In like manner the balsams and resins brought to us from abroad exude from different trees in these countries.

We frequently find that resinous substances are blended with a proportion of gum, forming that composition called a gummy resin; some of these when agitated with ψ form a milky fluid the gummy part being dissolved the resinous part is diffused throughout and gives it the milky appearance. The proper menstruum of gummy resins is Spirit of wine diluted with some ψ but if more ψ is added than is necessary the redundant part unites with the spirit of wine and hinders it from dissolving as much of the resin as it would otherwise do. If we evaporate a solution of a gummy resin we get the original compound the same as it was before it was dissolved, but if we add to the solution a quantity of ψ , the resinous part is alone precipitated while the gummy part remains dissolved in the ψ , so that this is the best method of obtaining a separation of the ingredients of this compound. The pure gums are but few in number but there being only three of them, but the resins are very numerous, there being many substances improperly called gums that belong to the class of resins.

Balsams & resins on exposure to heat yield a quantity of

Empid, odorous, essential oils. also aromatic oils, that have grown thick by exposure to the air or by keeping on being distilled they yield a quantity of oil that has recovered its former odour and tenuity; oils thus redistilled are said to be rectified. In these cases there remains in the retort a substance thicker and more consistent than the balsam or resin was before it was distilled.

There are three substances that appear to belong to the class of resins w^{ch} in some respects however differ remarkably from every other species of that kind. They are Camphor, Benzoin & Cashutchu; each of w^{ch} I shall consider separately by themselves. The first of these viz

Camphor

Is indestructible by fire or fossile acids, whereas the other substances that belong to this class, are totally decomposed by those powerfull agents. It is the produce of the *Saurus* of *Linus* a species of bay tree that grows in Japan. Camphor has a very aromatic smell, and as it comes from Japan is of a yellowish colour, but it is commonly purified before it is brought to us, & sold in the form of cakes of the shape of the vessel in w^{ch} it was sublimed. It is very inflammable, & during its inflammation it emits a very clear white flame with a very dark thick smoke. It differs from resins, for w^{ch} class it seems to belong by its evaporating wholly without leaving any residuum, or being altered by heat, & may be sublimed 1000 times without any diminution of weight. Since Resins it dissolves in Sh. of turp. and may like them be separated by the addition of water; it

is not affected by fossile acids, as it even dissolves in the O_2 with the greatest compression. This solution takes place very readily, and has an oily appearance, but it has none of the properties of oils for it is decomposed by Δ . This is a very singular property of this substance, & shews that its ingredients adhere more closely than those of any of the other resins: it dissolves also in the O_2 , but the solution has no oily appearance and turns brown by keeping. Neither mild nor caustic L^2 can be brought to act upon Camphor so that its decomposition seems to be the most difficult thing known, nearly as difficult as to change the baser metals into gold. - Scurman found that crystals form in the essential oil of Thyme we have the properties of Camphor, but want its smell.

Benzoin

Benzoin possesses all the properties of resins, but differs from them in one respect, that when exposed to heat, it yields what have been called the flowers of Benzoin, w^{ch} tho' they possess the smell of Benzoin, yet are totally different. One method of obtaining these, is to put some Benzoin into an iron pot & cover it with a conical cap of paper and to place the pot on the fire; after some time take off the paper shaking it as little as possible when you will find it covered over with the flowers in the inside; as soon as you take off the cap put on another in its stead, & go on in this manner till the flowers turn yellowish when it will be proper to desist. Another method is to employ a retort & receiver, or to extract from it its flowers by infusing it in boiling water. These flowers contain some of the aromatic principle of the Benzoin, and they

appear upon examination to be an acid having singular properties. They dissolve in boiling water, but wth difficulty, & they impart to it a sour taste. Whether this is a peculiar kind of acid or the $\frac{+}{2}$ and aromatic part of the benzoin combined is not determined. The *Syrax solida* & *Balsamum Peruvianum* on exposure to heat yield a little flowers. The third substance is

^{to} *Caoutchouc*

Or *Resin De Caen* as it is called by the French. This appears in the form of a tough leathery mass, and is formed into bottles being impervious to water. It is very inflammable & becomes fluid by heat. It is obtained from trees by incision, and is fashioned while soft into vessels of different according to the genius of the people. One of its distinguishing properties is its amazing elasticity; it was thought to be insoluble in every known fluid, till Mr. Macquer first observed that it can be dissolved in Aether, & afterwards separated & restored to all its original properties, but this requires a long time & a great degree of heat. There is still a 4th substance w^{ch} very improperly is called Gum Copal, which has long been admired by the Varnishers, as it is remarkably transparent & colorless, & so hard as not to impress wth the nail & as yet it is not known how it may be dissolved, by any except by the French; it would seem that they dissolve it in a mixture of turpentine & linseed oil. Once dissolved it in Aether but never was so lucky as to do it again, & I forgot how I had prepared that Aether I used the first time. I come now to the 2^d class of oils viz the Viscuous Oils

Unctuous Oils,

Are easily distinguished from Aromatic oils, by their want of smell and greatness, in consequence of w^h they are employed to diminish friction in machines. Expresed vegetable oils so called are the same as animal oils and differ only in consistence. Vegetable are secreted in them & deposited for the most part in the seeds of the plant so that it would seem that they are intended for the nourishment of the young plant. These oils when expresed are sometimes thin, and in other cases thick, as the Cacao butter, of w^h along with something to give it a colour Chocolate is made & this can easily be chewed by decomposing it. Another substance is the myrtle wax w^h floats on the surface of the water in which myrtle berries have been boiled, and w^h is made into candles of that colour, the colour being only accidental. Others are more unctuous as the oil of nutmeg, all these differ from fluid unctuous oils only in consistence. Animal oils seem to have arisen from vegetables & become solid by meeting with an acid in the organs of digestion. There are two kinds of oils in animal bodies the one in a separate the other in a combined state. To the 1st belong the fat & Marrow, the last of these differs in consistence in different animals, it is hard in the gregarious & soft in the carnivorous animals, to w^h last kind belong fish; In those animals w^h live partly upon vegetables & partly upon animals, it is in an intermediate state. The 2^d or combined oil, of this there are not many instances

some of it may be expressed from the yoke of an egg, & it may be obtained from those parts that yield much gluten, as the skin &c. it is in a fluid form, & is more properly diffused than combined; & these more properly combined we have no vestige till we separate them by the heat of boiling & in close vessels. All of these oils are lighter than water & on exposure to the air lose none of their weight or consistence, but are altered in their qualities & become rancid & animal oils do this more readily than expressed vegetable oils. This may immediately be discovered by the smell & one ought to avoid them as the most noxious of all substances. Attempts have been made to correct this rancidity by keeping them in a leaden vessel, or by throwing into them a bit of tin or a piece of its calx, the rancid heat acting upon and discolours the lead, but tho' by this they lose the rancid smell they become still more noxious than before, and this turns out a very dangerous practice. The oil thus treated may be detected by pouring some \ddagger when it will immediately become white.

Another practice to remove the rancidity of oils is to agitate them with \vee , to pour this off and add a fresh quantity, till it comes off tasteless; this is a very good method & may be done with a great deal of safety.

It is not well known in what rancidity consists Macquer thinks it to be owing to the separation of an acid & a new combination of parts. Viscuous oils are the most fixed of all fluid bodies require a considerable degree of heat to raise them & when distilled they are not the mild substances they were before, but they become empty.

empyreumatic. Therefore I shall first consider them with regard to mixture when in their true state, and 2^dly when altered by heat. In the 1st of these they are insoluble in ϕ & Spirit of wine w^t distinguishes them from essential oils if we suspect an essential oil to be mixed w^t some unctuous oil we have just to pour on som Spirit of wine w^t will dissolve all the aromatics leaving the unctuous oil untouched. This is also practised as a fraud to adulterate essential oils with ϕ of wine, but this is easily detected as in this case they become milky by the addition of water. They are not so violently affected by acids as aromatic oils are, as was shewn in a former experiment. Alkaline salts in their ordinary state that is half or wholly saturated with air have no inclination to combine w^t these oils; but if the ϕ is made caustic or nearly so, then it combines with oils & forms that substance so useful in manufactures and commonly called

Soap which differs in kind according to the species of oil made use of. These w^e are used in the composition of it are of two kinds. 1st the fixed vegetable & fopile ϕ , the union of w^t with the oil is promoted by boiling them together. In preparing these ϕ it is necessary that be as caustic as possible, for w^t purpose lime is used to attract from them fixed air. They are laid together into vessels in alter nate strata and water poured on them, and a ley is extracted, from them & put into proper vessels, as long as it continues to

come off heavier than ψ , & it must be strong or weak according to the kind of soap they want to make. After they have united the ~~soap~~ & the oil together by boiling them the composition remains dissolved in the water from w^{ch} it must be separated, this may be done in 2 ways & By evaporation, & this method is employed in the manufactory of black soap. The black soap made in this country does not consist wholly of whale oil & ψ but there is also some tallow mixed with it w^{ch} gives it that granulated appearance. 2. Hard Soaps may be separated from ψ by a double elective attraction. This may be done by means of two substances either χ or θ ; for it may be separated by means of the δ & w^{ch} the ley is made, & this is attended with no expense, and this process is called soap cutting, after w^{ch} it is made into square wedges w^{ch} still contain some ψ . The other substance is θ w^{ch} when thrown in attracts the ψ & the soap floats on the surface, but in this case the θ is lost, & the soap retains some of the salt mixed wth it. It is very odd that soaps are harder according to the fluidity of the oil by w^{ch} they are prepared, & the soap is the harder the more fluid the oil. Venice or Castile Soap is prepared of Florence oil & a caustic δ , w^{ch} is the hardest kind of this commodity, the variegated colour is given it by the workmen who colour the oils. There is another kind of soap made of oil of almonds w^{ch} is directed in the Dispensatory but it is seldom prepared as the Venice

soap answers instead of it for any purpose. Windsor soap is prepared of 2 lb hogs lard, the London brown soap is composed of resin and tallow wth 2 lb as the resin is cheaper, the making of this soap is rather more ticklish than any of the rest as there are some little circumstances very ready to make the operation give way. Soap contains 1/2 of water & of the remainder 1/4 is oil the rest is. Soap is very generally used as a detergent, & it is more useful than α in this respect that when it is now combined with the oil it attracts and unites with it more readily. 2^d It is more mild and is not so ready to hurt the cloth as α are. 3^d It may be rubbed without injuring the hands.

Soap dissolves wholly & very readily in St. of wine tho' none of its ingredients are soluble in it by themselves, & it is enabled to dissolve a larger quantity when heated, wth it deposits upon cooling. When we add to a solution of soap in St. of wine an acid the acid lays hold of the α while the oil arises & swims on the surface. When we examine this oil we find it to be different from wth it was formerly (1st) it is not so unctuous as before & burns more rapidly and vividly. 2^d We find it not to be so fixed, & that it has the property of aromatic oils dissolving in spirit of wine. This according to Mr Macquet is owing to the separation of an acid from it, so that it is by this means reduced to the state of an essential oil. Water does not break soap when it contains an acid. But if the α be combined wth an Ω or M^s the water wth contains it may be rendered soft

by dropping into it a solution of K as long as it continues to make it become milky, & then when the milkiness has subsided it may be poured clear off & free from any degree of hardness. This perhaps would be of advantage as a very small quantity of K is sufficient to be added to a large proportion of V & we might hinder the loss of soap & at the same time increase its detergent power.

When we distill an Ounctuous Oil it requires a heat equal to boiling Q , An acid liquor will come over first into the retort & will be followed by the oil more transparent & fluid than before & becomes soluble in M of wine, & it becomes purer & purer by repeated distillations so that there is no doubt but it might be at last changed into spirit of wine by continuing the distillation. The Rectification of unctuous oils is never performed with a view of use. All unctuous oils yield the principles I have now mentioned, but when we distill Tallow it also yields another oil, & an acid W is different from the H & W has a very pungent smell and forms with the \square of alum a salt W fixes some colours if the cloth is previously boiled in a decoction of some colouring matter & then dip't into a solution of this salt, & the colour turns out very beautiful & lasting if therefore it could be got easily it would be very great advantage to manufactories, but the preparation of it is very tedious & expensive.

I shall take notice of animal oils in their combined states
The gluten and bones of animals yield it, & it is got in con-
siderable quantity from the skin w^{ch} contains much gluten
This oil rises along with a quantity of S. & it is very
fetid & disagreeable, but when repeatedly distilled from
quicklime it gradually becomes more & more pure & it might
possibly be converted into Alcohol. Animal oil thus puri-
fied is commonly called *Dispiled Oil* from a Chemist who
prepared it. If instead of quicklime we distill this oil
from a S, ^{the R} it is rendered neutral by this means, & tho' it
does not unite wth S as formerly, it acquires the property
of precipitating S from its solution in S in the form of
Prussian Blue. I shall here consider some so-
called *fixed* oils some of the characteristic marks of
unctuous oils but w^{ch} differ from them in some respects
Sinseed & Walnut oils; they are not free of smell
bare viscid, but fluid in a great degree of heat. They
differ from unctuous oils in being exposed to the air
they lose in their weight so that they possess some
degree of volatility, & it is on account of this that they
are valued. They are insoluble in S^W of wine, do
not fly away at 212 & form wth S as thin soaks
they seem not to be so pure bodies as other oils, for
they lose in weight upon boiling & burn thick, & when
linseed oil is boiled it dries & adies in the air

I am disposed to believe that they contain some ~~essential~~ aromatic particles as well as unctuous ones, as the Oil fuses them alone of all the unctuous oils. Besides Sinsced & walnut oil there are three substances yet to be taken notice of which belong to either the vegetable or animal kingdoms. The first of these is Myrrour 2 Bees wax & 3^d ~~Myrrour~~ ^{Myrrour} Sarc.

Spermaceti is a substance entirely ^{an} animal substance. It appears in the form of a white fleshy ^{concrete} substance having a soft unctuous taste, it is the produce of a species of whale & is said to be got from the head of that animal. It is naturally solid but it melts into a substance keeping the properties of unctuous oils at 77°, and never varies in its melting point tho' some specimens of it require a stronger degree of heat than others. It concretes into plates the fibres of w^h run in one direction w^h have a greasy feel, & may be reduced into powder. It differs from unctuous oils in not forming w^h is a soap, w^h has been tried by some persons ignorant of Chemistry & it is on this principle that its purification depends as when fish oil is mixed with it, they may be separated by boiling in an alkaline solution, the spermaceti will float upon the top when the liquor

20
cools, & by repeating the process it may be made perfect-
ly pure. Some persons have failed in this, but it was
owing to their using well water, by w^{ch} means the u-
nities w^{ch} are contained in it, so that it cannot act
upon the oil, but w^{ch} river & it succeeds perfectly.

It has a particular smell w^{ch} at first is disagreeable but
that goes away upon exposure to the air. It becomes yellow
by keeping for some considerable time, but this may be se-
parated by steeping it in a solution of S, or in spirit of wine.
On being distilled it yields a substance like butter in consis-
tence, w^{ch} is not so disagreeable as the ordinary Animal oils.

It is said that some more important discoveries have been
made concerning it & that common fish oil may be reduc-
ed to Spermace, w^{ch} I suspect may be effected by exposing
it to the air for a long time, & this is not a mere ideal notion
for I succeeded very nearly in trying this experiment.

Bees Wax To the manufacture of animal, & some have
imagined to be an animal substance, but I have no doubt
in thinking it a vegetable substance, altered a little by the
animal w^{ch} collects it. It is got from the honey combs after the
honey is got out by heating & pressing them between iron
plates, the best kind of it is of an agreeable smell very like
that of honey & of a bright yellow colour, when new it is tough
not easy to break, but by age it becomes more brittle and loses
its fine colour & in a great measure its smell. Its distinguish-
ing marks are its unctuousity & that is partially soluble
in spirit of wine, & upon being distilled yields an oil that

is insoluble in Spirit of wine. It is always in a solid form till it is heated to 97° of Fahrenheit's Thermometer. It is changed into white wax by being made into thin flakes & then it is exposed to the air to bleach like cloth. A wooden cylinder half immersed in cold ∇ is brought near to a boiler in w^h the wax is melted & the wax adhering partially to the sides of the cylinder is drawn off in the form of broad ribbons extremely thin; w^h are exposed till they bleach white, but they do this only superficially, it is therefore found necessary to return them to the boiler again that they be thoroughly bleached so as to become entirely white; it is then reduced into cakes & sold in this form. By this operation it loses its smell, but its melting point remains.

It has been proposed to bleach Wax white by the fumes of the volatile sulphureous O_2 , some wax will not bleach if it has been made near vineyards. Bees Wax differs from all the unctuous oils by yielding upon distillation that is insoluble in Spirit of wine. Gum Sac as it is improperly called is a substance for w^h there is a very great demand. It being the principle ingredient in sealing wax. It seems to be a resinous substance as it dissolves in Spirit of wine, but it has none of the properties of resins except this one, for it neither dissolves in unctuous or aromatic oils. It is said to be got from some tree by incision, but this is not true, for it is collected by an insect, & I have seen persons who saw this, & these insects deposit it upon trees, or upon sticks w^h the Indians place for them to work on. It is sometimes brought over adhering to these sticks and is called *Atte Sac*, & in this state it is of a red colour as

the insectiare mixed with it. Sometimes the Indians beat it from the sticks, and wash away the coloring matter with Δ , it is then imported in the form of grains under the denomination of seed Lac. & when dissolved in Oil of Wine it forms a varnish. If seed Lac be exposed to a moderate heat it melts, & is then poured into shells, & when cool it has a dark coloured glassy appearance, & is called Shell Lac. Sealing wax consists of this substance mixed wth turpentine in small quantity, & it is then coloured black, red, or yellow by the addition of burnt ivory, vermilion & Verdigris. Though it dissolves in Spirit of Wine it will not mix with unctuous or aromatic oils, and it is perhaps owing to some alteration by the insects, that it differs from bees Wax. These are the principal observations with regard to these bodies that differ from the ~~various~~^{unctuous} oils. This brings me to the last class of inflammable bodies, viz the

Fossile Able bodies

Those bodies of this class found below ground. I might have considered Δ but I have already taken notice of it as it was necessary to be done that we might consider the effects of its acid on Oil of Wine. I mentioned formerly when speaking of precious stones that the diamond belonged to the class of inflammable bodies, & as it is a fossile I shall here consider it a little.

The **Diamond** is the hardest of all bodies, it is generally found in the form of octahedral pieces and it is not known if there is any rock the basis of it

of matrix of it, indeed it is very clear there is no such thing for
it is always found in detached pieces. Diamonds are found
in the Indies & several other parts of the world, & the larger
they are, they are the farther detached from one another.
Thus when they are small they are found in considerable
numbers in a small space of ground, but when large they
are far distant from each other. They are valued by the
square of the grains w^{ch} they weigh. Thus one of 3 grains is
worth twice as much as one of 2, one of 6 twice as much
as one of 4 & so on. When they are found they are rough
and have no lustre, but as they are heavier than earth they
separate from it when washed in w^{ter} & fall to the bottom
and then the workmen to ascertain that they are not pebbles
strike them wth a hard body, & hence when they are polished
many of them appear cracked & spoiled by this management.
When they are rough they are reckoned of half their value when
polished, & in their rough state no connoisseur can be a
judge of their value till once the external crust be removed.
They are polished only by one another & after this some
that before seemed good appear now to be cracked, or spoiled
by a mixture of foreign matter in the middle. Their colour
differs greatly, sometimes they are of a faint red, green or
of a flint white, but those that are transparent like
water are the best, the green are next, & the red or brown
ones are the worst. They are of a laminated or plated
texture w^{ch} is known to the diamond ^{cutters} as it will not
cut but in the direction of its fibres, & cuts glass only
in this direction, hence one glazier can cut glass

with only the diamond, as he has been accustomed to, while it is not in the power of another glass to cut it like diamond. Some have imagined that some of the precious stones were impure species of diamonds, thus Cronstan calls the Ruby the Red diamond but they are very different. There are some bodies brought from East Indies called Jagoons which are very like the diamond, & are frequently given by imposition to ignorant persons. The Diamond has none of the properties of ~~the~~ bodies, but is now properly classed with inflammable substances. It is incapable of fusion as it was exposed when mixed with the strongest fluxes to Somhousens Speculum by the Grand Duke of Tuscany & shewed no signs of melting. Diamonds on exposure to heat become colourless & flat & opaque, and if the heat is long continued they entirely dissipate. The Ruby by heat melts & takes an impression from a seal but loses none of its weight; the Emerald loses a little. No attention were paid for some time till about 10 years ago, it was observed by a French Chymist Mon^r Darsie that a diamond which he had put into a furnace constructed for the baking of porcelain, was dissipated when heated red hot, from hence he concluded that they might be distilled, & small ones combined together so as to form large ones. As they lose their colour on exposure to heat jewelers practise this method to destroy any bad colour they were tinged with. Dr Isaac Newton made a great number of experiments on the reflection of the rays of light, & he found that the bodies bend the rays the most, that spirit of wine bends

A more than water, oils more than St. of wine, & the diamond more than any of them, hence he concluded that it contained something inflammable. Mr Macquer renewed these experiments & all chemists now agree that it is unalterable in close vessels. From an experiment I made two or 3 years ago, I exposed a diamond upon a crucible under a muffle to a bright red heat, after a little it became prominent in the middle, & there appeared upon it an undulating flame w^{ch} increased more when the air was admitted; after it had continued in an hour I took it out when it appeared rough on the outside, I returned it again & in three hours time it was wasted to about the bigness of a pin head tho' before it was bigger than a garden pea; A Ruby that was exposed along wth it the whole time appeared like melted grease, but lost nothing of its weight. The diamond then belongs to the class of inflammable bodies & is among the heaviest of them, and suffers no alteration by heat if the air is excluded. These are the principle things w^{ch} regard to it. The next are the

Bitumens

Which are found under the ground, or upon the surface of the water of springs. They are divided into fluid, & solid bitumens. The fluid are the Fire Damp and the Petrolea; the solid are Amber, Ambergrease & pit coal. The Fire Damp is an inflammable elastic body, generated under ground & most

frequently to be met with in mines & pits, where it takes fire whenever a light is brought near it & occasions great destruction driving along with all the machinery &c. that comes in its way. There are two kinds of Damps the former of w^{ch} I mentioned to you before, it is the choke damp w^{ch} is found upon examination to be first air, and w^{ch} does not take fire when a candle is brought near it, but produces more fatal effects as it instantly suffocates those who inhale it; the other is the fire damp, of w^{ch} I am now speaking; it gives no warning of its approach till it explodes at once, & the most proper method to guard against it is to keep up a free circulation of air in the mine. & it is for this reason that it is most troublesome in autumn & spring when the air in the cavity of the earth & the atmosphere ^{above ground} are of an equal temperature. Sometimes the miners set fire to it themselves willingly in order to get free of it, as it infects principally the highest parts of the mine, one of the men takes a lighted candle w^{ch} he fastens to a long pole, & placing close on his face rears up the pole and sets fire to it w^{ch} may be sometimes done without any inconvenience. A very good way I have seen to promote the circulation of the air is bring a leaden pipe from the lowermost part of the mine, & to place the upper end of it in the ash hole of a furnace close upon all sides, by w^{ch} means the air is made to come from the bottom of the mine, to pass thro' the furnace. If in spite of all these methods it shall still remain in too great quantity, the mine must

be deserted. There is one thing this substance does not
 kindle with flint & steel, hence in valuable mines it has
 been proposed, that wheels should be made to turn w^e might
 make flint & steel strike against each other so as to give
 sufficient light to the miners, but this art is very pre-
 judicial to the health of the workmen. This substance
 is one of the most elastic inflammable substances known
 it is the same as that air w^e is separated during the
 union of S or Zc with the O^r hence Chymists that it
 is separated by the meeting together of these substances
 in the bowels of the earth. The

Petrolæa are found floating on the surface
 of the waters of spring in Persia & other parts, they are
 either light & transparent like Vitriolis Aethers, or more
 yellow, or even thick like tar, the fines kind called Naph-
 tha in Persia frequently is found on the surface of their
 springs & is discovered by bringing the candle near it
 when we draw the water. The thicker kinds of it are
 very like amber, and become thinner & thinner every
 time they are distilled. The thickest kind of it is the
 Petroleum Barbadosis, w^e owes its consistence to an
 acid, as we can by this addition change the Naphtha into
 a similar substance. There is a kind w^e is found in flakes
 floating on the dead sea, & is called Bitumen Judicum
 & ~~seems to be~~ ^{is} the worst of all, and seems to be like the
 residuum of Petroleum after Distillation

The next are the solid bitumens w^{ch} are 3 in number
The first of these viz

Amber everyone knows is found under the surface of the earth, of different colours such as clear, yellow or redish colour, & among strata of different bodies; in digging for the workmen generally first meet with a stratum of sand, next a stratum of white clay, then a stratum changed by its stay there, w^{ch} is not easily able below this they find an ore of vitriol. Under this digging deeper they come to a stratum of sand out of w^{ch} they extract quantities of the best amber. Hence the falsity of this assertion that amber destills from trees into the sea & is there digested, for it appears that it exudes from that bituminous wood already mentioned in a fluid form and is congealed by an acid it meets wth in the inferior strata, & this is the more probable as there are frequently insects found in the midst of pieces of amber w^{ch} could not happen if it had not been in a fluid form. Also when distilled it comes nearer & nearer to Persian Naphtha, & an acid rises along with the oil. It is found in the greatest quantity in Prussia, and also in the Baltic sea by the shore of Sudowia, where it is probable that the sea penetrating among the strata may dislodge from time to time pieces of the amber w^{ch} float on the surface & are taken up by the islanders. It is found usually in small pieces & when they are large, they become very valuable as it is then valued according to the squares. The pellucid kind is reckoned the best & gives the highest price.

Great attention has been paid to it on account of its property of attracting light bodies, but it is now known that this power of it is electrical, and that other substances possess a similar property; from this property being first observed in it, its ancient name electron has given name to the science Electricity. Amber when exposed to heat in a retort melts very readily, & if the heat be continued there comes over some phlegm, then a solid, salt, followed by a limpid oil, & towards the end of the distillation comes thick like serpentine, & there remains behind in the retort a quantity of charcoal. The salt is of a brown colour but may be made pure by dissolving it in water & crystallizing it, we then find it to be an acid, as it is destroyed by a red heat it is probable that it is a vegetable acid w^{ch} has been altered by mixture in the bowels of the earth. When the oil of amber is repeatedly distilled it approaches very near to to Peruvian Naphtha it is however very difficult to reduce it to this state, & I imagine that lime chalk or clay do not do so well as other substances to distill it from, & I have found it to distill better from ∇ , than any other addition I have ever used. Amber is soluble in Spirit of wine but in very small quantity, but if the spirit is impregnated wth \odot in the form of sweet spirit of vitriol it takes up much more. Amber is not much used but in varnishing, but as it dissolves wth so great difficulty, it is first burnt black, when it dissolves in oils and forms a dark brown varnish that appears black when thick laid on.

Very like to Amber is
Ambergrease But differs from
it by having a laminated texture and a different smell
and consistence it is the same as $\frac{1}{2}$ of wax. It is said
to be a marine bitumen, washed from the bowels of the
earth & it undergoes some alteration in the stomachs of
fishes who swallow & again eject it. It is found in the
East Indies, & at Madagascar in considerable quantities
and sometimes pieces of it are found on our shores. The
best kind of it is of an ash or grey colour with yellow spots
spread upon it. It melts at moderate degree of heat &
when cool does not recover its former ^{colours} transparency but turns
black; it also burns with a very fragrant smell below
of 312 of Fahrenheit's. It yields on distillation the same
substances as amber does, & is as insoluble as it in spirit
of wine. The smell of it when in a large mass is rather
disagreeable but when diluted it is very fragrant.

This is the account that has generally been given of
it, but in the memoirs of Berlin we meet with a quite
different account, where it is said to be of vegetable ori-
gin & to have flowed from a tree & undergone some
changes by floating in the ocean, or by remaining un-
der the earth. The tree is said to be the Guaiacina Gummi
in America & yields a milky juice that changes to
ambergrease; in this dissertation the analysis of this
juice is not mentioned, if it had it might have fixed
ambergrease among the Resins —

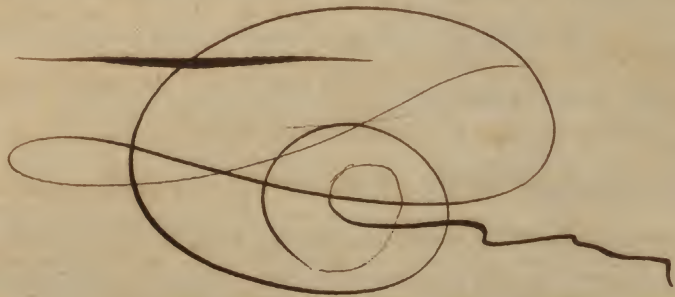
40
The last inflammable substance I shall mention

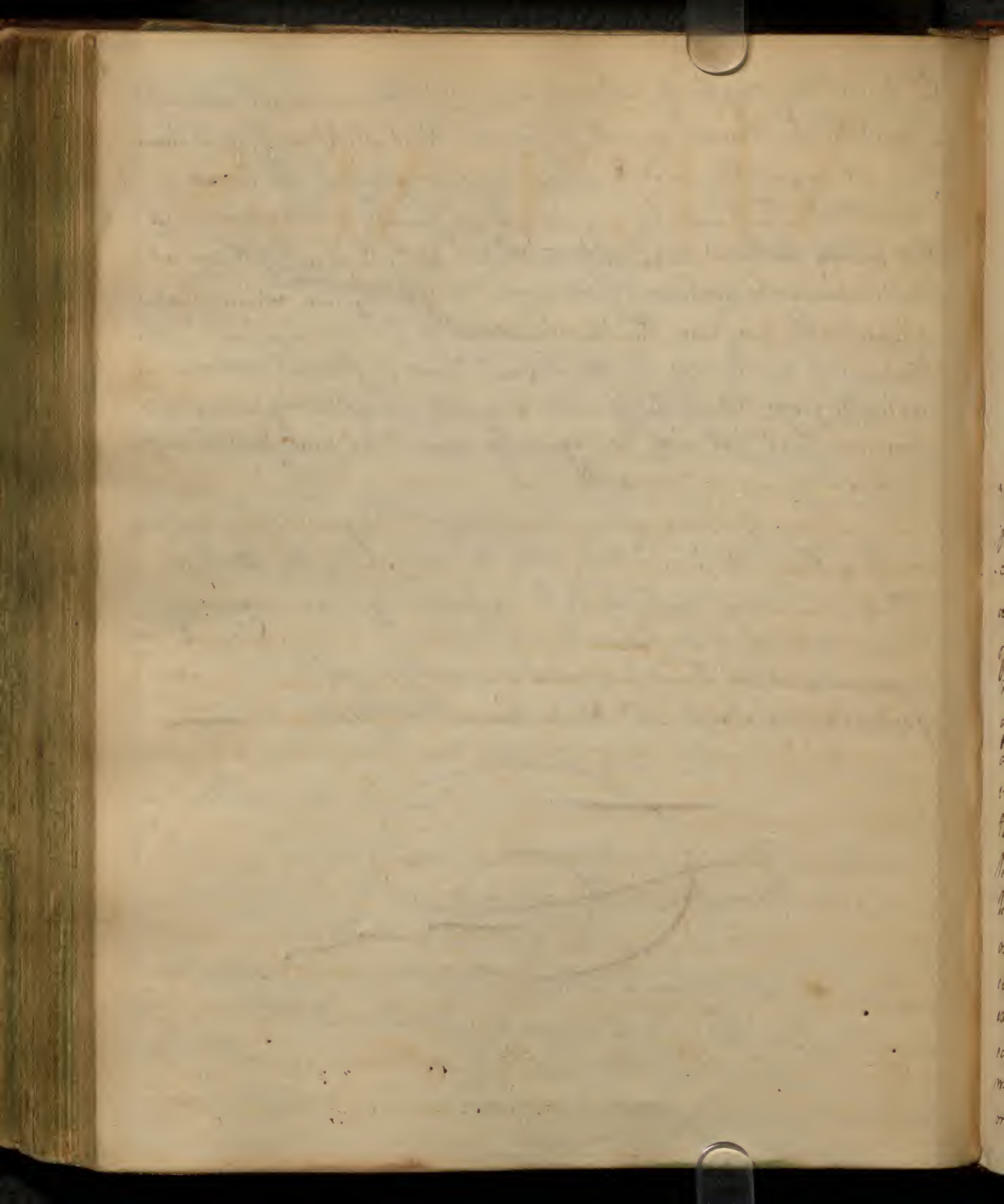
is **Coal** which is found in greater quantity and is of more use than all the other inflammable substances put together. It is for the most part of a woody texture, & besides this & its colour it resembles very much amber and ambergris, but it contains rather a greater proportion of earth than they do. It yields by distillation substances very similar to amber, only its oil is darker, yet if many purified like to Naphtha, it yields also a little salt, but no 8. We meet with the coal in various states wth regard to texture, and often Δ is mixed with it, or pyrites wth contain Δ . Fulkenny coal contains so little Δ ble matter as to burn without flame, hence it may be employed as charcoal to dry matt. There is another species of coal that breaks into cubical pieces, wth colliers call Parrot coal, from its shattering while it burns. Another kind is the splint or candle coal, on account of the clearness of the flame it emits. When we examine these species of coal we find that the splint coal contains most inflammable matter, the parrot coal the next & the Fulkenny coal least of all. But besides this there is no other difference for all of them contain Δ and charcoal. This it seems to be clay mixed wth a little

Q. What the origin of pit coal is, is not determined wth accuracy; I think that opinion is not ill founded that suppose them to have been all originally wood, & altered by their stay in the bowels of the earth. The principle argument in favour of this opinion is the woody texture observable in them, & indeed all of them appear to have the texture of fir, except the splint^{coal}. This opinion also is reasonable as from the turpentine of fir when mixed with the acid of pyrites viz the O_2 a substance is formed not distinguishable from the oil of pit coal. I would therefore agree in this opinion, that pit coal is originally wood that has been changed by its stay under the earth.

These are the principle observations wth regard to the inflammable bodies; We proceed then to the 4th Class viz the Metals.

They come very properly to be considered here as in some of their properties they resemble inflammable bodies, & an intimate acquaintance wth their properties can only be got by a previous knowledge of Salts, O_2 & Inflammable Bodies





METALS.

In the more early ages Metals were considered as the only objects of Chemistry, & many curious Theories were formed concerning them, & particularly they conjectured that they were all at bottom the same, & differed only in various degrees of purity, & that by freeing them of their impurities all of them might be converted into ϕ . In consequence therefore of the attention paid to them by the Alchemists, more has been discovered by these persons than by their successors; & perhaps it might be thought that nothing farther can be added to their descriptions, but as they considered them only as in their search after ϕ , they overlooked many observations that have since been made by persons who considered them as distinct metals, & new discoveries are every year made concerning them. As the Knowledge of metals is very extensive, it is impossible on that account for any one who considers them only as a part of the Chemical course, as they might done by those who treat of them alone. I shall therefore only mention the principle circumstances with regard to them

& what is omitted on this subject may ^{be} very ^{richly} supplied by books. The Metals are the most useful of all bodies both in the useful & ornamental arts, and particularly in Medicine, & the operations performed on them are of all of them entirely Chemical. First then I shall consider their general properties & then proceed to examine each of them in their Order: & the order I shall is one not generally followed, viz I begin at the more imperfect & proceed, in order to the most perfect. & first their general properties.

Metals are 1st The Densest of all bodies, 2^d The most opaque. 3^d The most perfect reflectors of light. 4th The most perfect non-electrics & 5^{thly} the most durable of all bodies.

We regard to their first property, viz Density: no body contains so much matter under the same surface as they do, the lightest of them being ^{nearly twice as heavy as} the heaviest of all the earthly bodies viz the marmor metallica whose weight to ∇ is as 4 to 1 whereas the lightest of metals viz ∇ weighs to ∇ as 7 to 1.

It has been imagined that \bigcirc the densest of all the metals is not absolutely solid, but has vacuities betwixt its particles, & there is reason to believe this to be true at the same time the experiment commonly shewn to prove this is not a conclusive one; it is to put a piece of gold leaf between two pieces of glass and to look at it between the eye & the light, when small crevices will appear in it; but these crevices are formed by the hammering causing a rigidity in the particles of the \bigcirc during its formation into leaf & we could by no means be prevented but by heating the metal red hot now & then during the operation, but this

cannot be done to it without melting it. We learn then that
the most opaque of all bodies, as silver bodies when reduced
into thin plates are diaphanous, while they are perfectly
opaque & this property will distinguish them from all other
bodies. It is owing to this that they possess their third pro-
perty, viz that of reflecting light more copiously than any
other bodies, hence they possess a degree of lustre of w when
they are deprived, they at the same time lose their other va-
luable properties. Their fourth property is that they
are the most perfect ~~non~~ conductors, as they will not allow
electric matter to be collected up on them by rubbing but it
passes from them exceedingly fast. There have been some
experiments published lately in the Philosophical transactions
w^{ch} seem to contradict this assertion. The experiment is this
a piece of metal is insulated by cementing to the end of a
stick of a wax, or of glass, & it is then rubbed wth a piece of
fur, when it becomes electrified, and the matter is accumu-
lated on the metal. But this experiment is no way
conclusive for the electric matter is collected on the skin of
the animal w^{ch} the metal is rubbed, & being accumulated
on the metal w^{ch} is insulated it cannot pass from it to the
surrounding bodies. We may then conclude that metals
are the most perfect conductors, or non electric. Their
5th property is their ductility viz that of stretching in
every direction when struck by a hard body without any
discontinuation of their parts. None but metals possess
this property & on this account they are most useful
tho' all of them have this property yet some of them have
it in so great a degree as to exceed human imagination
hence they have been distinguished into metals and

semimetals, the last of us do not shudder under the hammer but tho' this distinction has been universally received yet it is impossible to say where ductility ends or begins, & I think it a principle not sufficiently ~~ascertained~~ ^{ascertained} accurately however it is still retained, but I will show you another way to ascertain their differences when I come to the 2^d part viz to speak of metals in particular.

When we want to discover their properties we must have recourse to the Chemical agents heat & mixture. With regard to the effects of heat all of them are fusible by fire & may be easily melted by the heat of our furnaces except one which has lately been added to their number, viz Plasma which melts only in the focus of a burning glass. When they are melted the aspect in the form of a shining fluid w^h like metals is never transparent, nor does it adhere to the vessels wherein it is melted w^h properly is peculiar to metals. The appearance of metals however when melted may be conceived by looking at a quantity of Φ w^h indeed is a metal in fusion but requires a very small degree of heat to reduce it to that state. Many of them when exposed to a violent heat rise in the form of vapour & if a cold body be brought near them they adhere to it, & we find them to be altered, and in a powdery form; but if we expose them to the same heat in close vessels, so that they do not come into contact with the air, they then rise in form of vapour, and upon cooling return to their original state. The most perfect metallic substances are perfectly fixed, while those called semimetals are volatile in a certain degree and may be distilled.

Metals seem from what I have mentioned to be constituted like
 inflammable bodies, as they undergo no change by heat if at
 the same time they do not come in contact with the external air.
 They also appear to have one of the ingredients of inflammable bodies
 and viz. the Δ , combined wth matter different from that of inflam-
 mable bodies & this is the reason of the difference betwixt them and
 inflammable bodies. The substance combined wth Δ in Metals is some-
 thing like an earth, but it is more dense than earths are, and
 is capable of vitrification. Upon the Δ depends the shining
 and ductile qualities of metals, & when they want this they are
 in a powdery form, & are not such perfect Non electrics; then they
 are also not so easily melted, and when melted, they are not so
 opaque, being changed to a drop of glass, & then they stick to the
 vessels wherein they are melted. That Metals contain Δ
 may be shewn by many considerations. One way is by defla-
 grating wth Nitre and we find that all of them do this in a
 greater or less degree. Nitre however wth more difficulty on metals
 than it does upon inflammable bodies, & the heat and light pro-
 duced is not in so great a degree, wth shews that the Δ is more in-
 timately united wth the other ingredients in Metals than it is in
 inflammable bodies; after the deflagration the calx of the metal
 remains mixed wth the Δ of the Nitre, wth may be washed away
 by pouring upon it a quantity of V. when the calx will remain by
 itself. That they contain the Δ may be shewn more obvi-
 ously, as by exposing them to heat wth the concurrence of fresh air
 they caline i.e. change into a powdery form, & during this some
 of them produce a degree of heat & light not equalled by the
 most perfect of the inflammable bodies the Phosphorus of Frankfurt
 for example Zinc does this, and is by this means reduced to a

heavy powder. In other cases they do not burn wth such violence but slowly like charcoal notwithstanding during this they emit a manifest light; hence all of them contain in their composition the Δ , but to shew the truth of this doctrine take the calx thus formed & restore to it the Δ , and you will produce the original metal wth all its properties.

Metals when exposed to heat differ greatly wth respect to the quantity of Δ they give out & the manner in w^{ch} they part wth it. Some that contain a great deal will not part wth it, while others part wth it very readily. This has given occasion to another division of the Metals into Perfect & Imperfect. The Perfect Metals suffer no change by the most violent & lasting action of fire while the Imperfect may be deprived of their Δ by means of fire & consequently of their metalline form. To the class of perfect Metals belong O & P Platina. Among the Imperfect some part wth their Δ slowly & are not attended wth any remarkable appearance of this kind as I ; others part wth some of their Δ easily but obstinately retain the rest such is K , others part wth it wth great readiness & wth all the violence of an inflammable body and when collected after this they are found in form of a heavy powder that cannot be converted into vapours again, or be melted into metal as before without addition; hence the Volatility and fusibility of metals depends upon the Δ . Another circumstance is that the calx greatly exceeds in weight the metal from w^{ch} it was produced, sometimes $\frac{1}{2}$ or $\frac{1}{10}$ part. Those metals too that are capable of being most calcined yield the heaviest calces, & we may judge of a metal's calcining by its melting, if it melts easily it will not calcine much but if

It melts wth difficulty & will calcine to a great degree. Many
hypotheses have been formed concerning this increase of weight
of the calx of the metals; One of the most favourite ones at present
was that the Δ had the properties of rendering bodies lighter
& so the calx says they become heavier by the separation of the
sublimed. But the true cause is from the absorption of air
w^{ch} is very different from fixed air, being as pure as that we
we breathe, & the quantity of air that may be separated
from the calx is sufficient to account for the increase of weight
for 86100 of red lead viz the calx of lead will yield 1/4 cubic in-
ches of this air; & if we take the calx of Φ and destill it from
a retort wth the end of the retort placed in a vessel full of water
we will obtain from it a great quantity of air, & we will
find that the Φ will have lost after it is destilled in the pro-
portion to $4\frac{1}{2}$ grains to $\frac{3}{4}$ of the wt it had when in a calcined
state. This experiment does not succeed in other metals
as they do not regain their original properties on exposure
to heat without addition as Φ does; but we can shew that
the calxes of these metals also owe their weight to air, by ex-
posing an acid w^{ch} unites wth the calx expells the air. When
we mix the calx of a metal wth charcoal dust & expose it to
heat so as to convey the principle of inflammability, then a very
great effervescence is occasioned by the separation of the air
from the calx, but as charcoal alone is not so convenient &
cannot be brought into a wthin the Chemical attractions for
the calx, therefore it is of use to add to it previously a quantity
of Δ , & I mentioned a composition of this kind formerly by the
name of the black flux, w^{ch} upon exposure to heat melts and
brings the charcoal in contact wth the metal calx.


During this reduction the materials swell considerably from the separation of air from the calx, so that it will be necessary that the vessel in w^{ch} we operate be capable of containing double the quantity we put into them else they will be thrown out and lost. The only objection to this ebullition being owing to the separation of air from the calx is that charcoal contains much air in its composition, & indeed it arises from both these substances, but that w^{ch} comes from the Charcoal is fixt air while that from the calx is pure, hence during the separation by means of charcoal the air separated extinguishes a candle, but when we separate the air from the calx by means of an acid it then allows the candle to burn very well. These are the principal things in general with regard to the reduction of metals & Calination of metals. In some cases the calx requires no farther treatment but to be thrown into the fire when it will attract the Δ from the coals and fall to the bottom of the furnace. I come now to consider in general the effects of mixture upon ~~and~~ metals and I shall first consider the effects of acids on them.

Acids have a stronger attraction for Metallic bodies than any other salts have, and form wth them compounds called metallic salts. Their order of attraction for them is different from y^t which they observe in combining wth me^{tals} & earthy bodies; being in this order 1st O² 2nd O³ 3rd O⁴. During this union an effervescence is produced, w^{ch} was supposed to be owing to the separation of fixt air from as in Δ & \square but it is easily proved that this is not the case, but that it is owing to y^t separation

of the Δ , and this may be determined by making the fumes
that arise to pass thro' a solution of caustic & or thro' lime
& neither of w will be altered by it; & what confirms it to be
the Δ is that if to a solution of a metal in an acid I add an
 x perfectly saturated with air, the metal will be precipitated
in the form of a calx, and will be as perfect a one as if it had
been made by fire. That it is owing to the Δ escaping wth part
of the acid is farther proved by this, that the calces of many
metals are soluble in acids & do this without effervescence, thus
red lead dissolves in the Ox without any commotion so that it
is not owing to the separation of air. It may be farther
observed as a proof of this doctrine, that one metal may be pre-
cipitated in its metallic form by another. Thus if we add
 Zc to a solution of D in the Ox , the Zc unites wth the x and the
 D is thrown out, & this takes place without any effervescence as
the Δ separated from the Zc is attracted by the D as fast as it is
separated; so D precipitates D , and these are to be held double
elective attractions there being four substances, viz The two metals
the Ox and the Δ . When a metal is precipitated from its solu-
tion in an acid by a caustic or a mixture it acquires some increase
of weight, w^{ch} experiments I cannot see how they may be reconciled
to the ^{general} doctrine, I cannot therefore account for the increase of weight
in these cases. Also if I dissolve $\frac{1}{2}$ of D in $\frac{1}{2}$ of Ox they will
increase in weight 14 grains.

Metallic Substances wⁿ combined together melt more easily
than they do in a separate state, thus K & Vin when joined
together melt at a less degree than tin does tho' lead melts

with greater difficulty by itself than tin does; so a compound of Q and V requires less heat to melt it than M^{us} melts easier than Q does; & it is easy to make a compound Metallic body that will melt below V^{is} the heat of boiling V.

The Salts of metals melt into glasses of different colours when exposed to heat ~~at proper~~. The Salt of Q runs into a white glass called from its use white enamel; that of R forms a green glass the salt of  forms a yellow glass, and that of K is used in the making of Crystal.

They have been divided into Metals & Semimetals from their ductility & brittleness, but the terms fixt & Volatile will answer better, but even in this way they run into one another as K belongs to the class of metals may be raised by heat.

I shall next proceed to treat of them in their order and the order I shall follow is one not generally observed, viz I begin wth the most Imperfect / those that can wth most ease be deprived of their A^{ir} & proceed in order & finish wth the most perfect of the Metals, & I shall only deviate from this order, where it is necessary in order to discover the properties of some metals; & the first wth I begin wth is Arsenic, w^{ch} is commonly found combined wth metals when one are reducing them from their Ores, it will therefore be necessary to be previously acquainted wth its properties

Arsenic

Arsenic has long been considered as not belonging to the class of metallic bodies as it only possesses some of their properties, but there is no doubt of its being a metal, from its weight and because it may be deprived of its Δ by calcination.

I shall first describe it in the ordinary form in which it is found viz that of a calx in which form its most frequently to be met with. It differs from every other metalline calx in being volatile whereas the calces of the most volatile semi metals are perfectly fixed, in this state it is incapable of fusion as it rises wth a less degree of heat than is sufficient to melt it; it differs from them in some other respects viz in its being soluble in some degree in water and its presence may be discovered by its smell of garlic when it is heated, and possesses very corrosive and poisonous properties there being no substance which will take away animal life in so small a quantity. Medical persons have often fallen into blunders when examining if it has been owing to it that persons suspected to be poisoned have died suddenly but this is very easily known by the effects it produces and by examining the appearance and the contents of the stomach. When we judge from the effects produced we cannot be so certain, as the pain, vomitings, reachings thirst &c. that accompany the use of it may be produced in some diseases. It generally corrodes the stomach, and in all the instances I have seen this was found to be the case. The best way to discover if these symptoms have been owing to, is to collect carefully the contents

of the stomach after death, and to wash them in some of the coldest water that can be got, and to collect the matter w^h subsides to the bottom of the vessel, after having dried this in a gentle heat to mix it with some flour and to lay the mixture on a piece of iron w^h we heat in the fire, and if the vapour w^h arises from it has the smell of garlic then we may be certain that the person has been poisoned by means of arsenic. The vapour does not arise from the garlic till it is near red hot, so that least we should mistake the burnt smell of the flour for that of the garlic: we may put the matter suspected into a crucible along w^h a little olive oil, by the smell of which there is no danger of forming a wrong opinion. Another method is to mix it w^h olive oil and put it between two halfpence when after they are heated the Δ will be tinged white if the substance suspected is ~~garlic~~ arsenic, but the former is a more conclusive experiment. Tho' it is so destructive to the human species yet when given to dogs they sometimes escape it as alive but it deprives them of the use of ~~their limbs~~ of their hind legs; so common salt w^h is found to be perfectly harmless to the human species kills birds that choose to eat it.

That Arsenic is oftenest found in form of a calx, yet the Δ may be given to it when it assumes a metalline form. The method I use is to mix the calx with some olive oil and to expose it to heat, when it sublimates in the form of polished steel and is then called Regulus of arsenic, but it loses its Δ , and consequently its metalline lustre on exposure to the air. In this state it is heavier than when in the form of a calx, and does not dissolve nearly so readily in water.

Libi of Δ when boiling but takes up $\frac{1}{2}$ of the calx of arsenic but a quantity of it separates from the Δ as it cools, therefore when it will be of advantage to use as cold Δ as we can get to wash the contents of the stomach when we collect them for examination.

Regulus of arsenic has not been applied to any useful purpose it calcines into a grey coloured powder on exposure to the air & when heated emits a garlick smell. It is not much disposed to dissolve in any acid but the Δ . The Principle things that remain with regard to it are its effects upon Δ , and nitre.

W^t the vegetable and fofile & it forms a substance of the consistence of glue, called Hepar Arsenici, and crystals form in its evaporating part of its Δ . This composition can be decomposed by any Δ and has been applied to no useful purpose. Caustic & are best for making this compound. If we add to nitre an equal quantity of arsenic in powder, and expose them to heat in a retort with a receiver luted on, the Δ comes over highly phlogisticated and of a blue colour, while the residuum tho' it consists of the same ingredients possesses properties different from the hepar arsenici; this change of the Δ was known to Stahl but the residuum was first examined by Macquer who found it to be possessed of singular properties, and called it the neutral salt of arsenic. The hepar of arsenic may be decomposed by heat alone, but this is not the case with the neutral salt of arsenic. This compound cannot be decomposed by the strongest acids, but upon adding a solution of some of the metals in an acid to it, it is decomposed by a double elective attraction the metal uniting w^t the Δ and the Δ of the neutral

salt with the acid. The neutral arsenical salt may be decomposed by any body that contains Δ as charcoal, & I believe that this salt is not possessed of poisonous quantities as it does not deprive dogs of the use of their hind legs upon w^{ch} its effects has been tried. This salt is never used in medicine, but is of great use in the manufactory of fine glass; it is also used in dying of some colours by the French.

Of inflammable bodies Δ unites wth arsenic, and the compound is called Yellow Orpiment, or if there be a great proportion of Δ red orpiment. This compound may be decomposed by mixing it with a strong solution of δ , and after gently drying it, we expose it to heat in a cucurbit fitted with a blind head, the arsenic separates and rises into the head in the form of flowers while the Δ remains combined with the δ in form of a bepare.

Orpiment is found to be perfectly mild with regard to its effects on the human body; and this is worth remarking that all metals are deprived of their activity when combined with Δ . Thus Δ in the form of an Ethiops mineral is perfectly inactive. Arsenic is never found pure in the bowels of the earth, but is always combined with some other substances, and frequently it is blended with the ores of metals particularly wth those of Cobalt w^{ch} contain a great deal of it. These arsenical ores are by the workmen thrown into a large furnace mixed promiscuously with the fuel and the arsenic rises by the heat in the form of a vapour, and is condensed in a long winding flue thro^{ugh} w^{ch} the vapours pass, ^{but} it is not on account of its value that it is thus collected, but because it is necessary by this means to prevent its poisoning all things around

I shall now mention a few things concerning the ores of metals. These are metallis substances that are found in the bowels of the earth, united with several sorts of stones semi-metals, sand, &c., and when the metallis matter is combined with any of these, in such quantity as is capable of being separated with advantage and profit these compounds are called Ores. Ores generally contain in their composition either Δ or O , and sometimes both of these substances. Metals may be found in four different ways, 1st In their metallic state, 2^d Combined wth Δ 3^d combined wth O , and 4th In the form of a calx by itself. O is always found in its metallic form, in form of wedges, or of grains diffused throughout a quantity of sand or stony matter; Δ In this country is found in form of an ore wth Δ or O , and generally in the form of a calx. In reducing metals from their ores three things are to be attended to, 1st To free the ore from any earthy or stony matter wth they are generally superficially combined, this is effected by elutriation, viz by pounding the ore and washing it in W : so the bottom of wth the metalline parts presently sink as being the heaviest, while the small particles of earth remain suspended some time longer and may be poured off. 2^d To free it from the Δ or O it contains, ~~and 3^d To restore to it the Δ~~ This is done by exposing them to a sufficient degree of heat for a certain length of time, and if the Δ be wanted by themselves

They may be catched and collected in proper vessels or places..
The 3^d circumstance is to reduce the metal thus freed from heterogeneous matter to its metalline state which may be effected by exposing them to heat in a crucible wth some of the black flux, or as is often done in the large way of working they throw the ore into the fire so that it comes in contact with the fuel, and receives from it the Δ , and falls in its metalline form to the bottom of the furnace. When it is found blended with earthy matter requires only to be washed and melted in a crucible without addition, or it may be separated from the earth by amalgamating wth Φ w^h unites wth it, and may be forced away again by heat, and condensed in a proper receiver, & this is practised in the mines of Spanish America.

The next metallis body I shall consider is Φ not because it is the next imperfect one, but because the knowledge of the experiments performed upon it will be far more useful in performing similar operations on other Metallis substances.

Mercury

When pure and undisturbed always in the ordinary heat of the air appears in form of a shining fluid substance whose weight to ∇ is as 1440 to 1. It was long thought

incapable of acquiring a solid form without addition, but from
the experiments made at Petersburg by M. Browne, and
at Port Pallas in Siberia it has been discovered that at the
148 degree of Fahrenheit's thermometer it assumes a solid
form, and then is possessed of some degree of malleability.
It therefore differs from all other metals in having its mel-
ting point at so small a degree of heat. Since its vola-
tile or vaporific point is lower than that of any other
metal & it rises at 672 of the thermometer and it may
then easily be distilled in a degree of heat less than is needful
to make it red hot. When it boils it makes a bubbling noise
owing to its gravity; when thus distilled it does not lose
its Δ ; even tho' it is converted into vapour in the open air
for if a cold body is brought near to it in this state it con-
denses in the form of streaming Φ . It unites wth and dissolves
all metallis bodies except Φ and Ψ , when they are in their
metallis state i.e., saturated wth Δ ; and these compounds are
called amalgams w^{re} soft & fluid according to the quantity
of Φ they contain; it is a practice to adulterate Φ with Λ or
 Υ or Bismuth, but this cheat may be discovered by its
not forming into spherical globules as pure Φ does when laid
on a piece of paper, or on the hand, but it forms globules round
at one end with a long tail behind, also by its tinging the
hands of a bluish or black colour; also by a crust forming
on its top on exposure to the air; but this last circumstance
may be fallacious, as it may acquire such a crust from
grease falling into it, or dust, and it may be freed of it
by passing it thro' a very small glass tube or straining

A thro' leather, and it must be purified thus for making
 thermometers. When it is adulterated with K or any other
 metal it can only be separated by distillation. This may
 be done in a glass or S vessel; but vessels of any other
 metal will not answer for it contracts an union with every
 one of the metals except S ; it is also common to add some S
 filings to it, to give it a lustre, as it attracts from them
 some Δ during the distillation. It leaves behind it every
 time it is distilled a little red powder, and if a quantity
 of it is kept for some months in a vessel, placed in a sand
 bath, heated to such a degree as to raise it in form of vapour
 while the head of the vessel is kept cool so that it will
 condense and fall back again, it will at length turn into
 a red powder called *mercurius precipitatus per se*, it is very
 impure, as it is not a precipitate, not having been se-
 parated from any menstruum in which it was dissolved, it
 ought therefore to be called calcined S , but it hath only the
 appearance of a calx, for if it is exposed to a pretty strong
 degree of fire it rises and assumes the form of running S .
 Mr Boerhaave also exposed it to a degree of heat less than
 is sufficient to distill it for 15 years both in open and in
 close vessels, and observed that it suffered no change, hence it
 may be concluded that it holds with great difficulty with
 its Δ . It was much attended to by the alchemists, and
 many projects were fallen upon to deprive it of its fluidity
 but it proved to be a problem, as difficult as the making
 of C and D ; till at last they employed it in medicine

when they met with very great success. In its natural
state it is totally inactive in the body, its particles not being
sufficiently divided to enter the absorbent system. But
if its particles are deprived of their mutual cohesion, then
it acquires some degree of activity, this may be done by
grinding it with any tenacious substance. Sometimes
it has happened that when taken into the stomach in its
crude state it has produced after some time very violent
effects, w^{ch} could only happen by its stagnating in the sto-
mach or intestines and agitated along with the mucus of these
parts by their peristaltic motion so as to be rendered fit
for entering the mass of blood. The substances used to
divide its particles, are generally fatty ones matter, with
w^{ch} they must be carefully and accurately grinded, till all
none of the globules can be seen by the eye. The Greek phy-
sicians suspected it to be poisonous, and dared not to con-
-tinue on it internally but they applied externally in this
form, when it is absorbed by the inhaling vessels of the
skin and produces its effects on the body, The alchemists
afterwards ventured to give it internally in its divided
state. Another method of dissolving the cohesion between
its particles is to triturate it with gummy substances
a compound of this kind was first prepared by Paracelsus
and has accordingly got the name of his solution; it is pre-
-pared by rubbing it with mucilage of gum arabic till the
the globules entirely vanish. The mixture then becomes

diffusible thro' water and imparts to it a black colour. This preparation possesses a good deal of activity, and frequently proves emetic; It as well as the ointment turns to be much more active when kept for some time than when they are new made, this is particularly the case with the ointment so that it would seem that some of the ingredients of the feet acquire a most intimate union with the Δ ; accordingly when we melt mercurial ointment that is new made the Δ subsides to the bottom, but after it has been kept for some time, the Δ cannot thus be separated from it.

Tho' in these preparations Δ is sufficiently active when they are well prepared, yet it never can acquire so great a degree of activity as when deprived of its fluidity by acids; and in this way are made a great number of preparations. The Oe dissolves it, but the Oe does it with more facility, the Oe has no effect on it in its metallic form.

The Oe does not act upon Δ in the common heat of the air, but must be heated boiling hot to dissolve it, during their union vapours arise w^h is the Oe in a sulphureous state impregnated wth the Δ of the Δ ; if the ^{excess} solution (as it always is) is evaporated to dryness, there remains some white matter in the bottom of the vessel w^h is called vitriolated Δ w^h is very corroded, and is itself not applied to any purpose but is frequently prepared as from it

is got by washing it in water a yellow Powder called
Turkish Mineral it is a violent Emetic and it was some
ly used in venereal cases. When we make this solution
we use the following proportions. We take ℥vi of Ox and
℥iv of Z , we put them both into a small matrass
and set it over the fire till the Z is all dissolved and
the compound left perfectly dry, and in this case the
preparation will ~~will~~ endure a much stronger degree
of heat than Z itself will do. We then pour upon it
a quantity of warm water upon which it immediately
separates into 2 parts the V extracts a little of the Z
and most of the acid, and the Z it extracts may be pre-
cipitated by adding more to it. If the solution has not
been evaporated to dryness, as much of the Ox will re-
main as is sufficient to render the whole soluble in V
so that little or no separation will take place. After
having washed the Turkish Mineral it falls to the
bottom several times with warm water, we find it to
be a yellow calx of the Z with a very small proportion
of Ox in its composition, about two grains of acid to
℥i of the Z . The Ox acts very readily on Z and
it is necessary that it be previously diluted with its weight
of water, when we find that ℥i of Aqua fortis will dissolve
as much Z attended with fumes and heat, and when the

Solution is allowed to cool, pyramidal crystals form in it. This mercurial salt is extremely corrosive, and when applied to the skin it burns it like a red hot iron. It is only employed in external use as a caustic, & may be made use of to mark cloth with as the stain of it does not wash out but for this purpose Lunar caustic is much better.

If this salt is exposed to heat in a glass vessel it turns dry and appears like a white powdery mass, if the heat be urged still more it becomes first yellow, and then red, almost all of the O₂ being forced off by the fire, and the whole secret of making this preparation is to expose it to a due degree of heat and no more, so as to give it a shining red spiculated form for if too little or too great heat is applied it will be of a brown colour. This preparation is known by the name of red corrosive & or red precipitate. It has usually been directed to prepare it in a phial but this is altogether improper, as the colour depends on the quantity of acid separated from it, so if we do the operation in a vial I know from experience we will never succeed, for tho' we continue the heat till the preparation has acquired its red colour, yet the fumes of the acid that arise from it float in the top of the phial, so that when we remove it from the fire they fall back again upon it and change its colour to a brown as it cools; but the operation succeeds better if performed in a shallow vessel, the segment of a Florence flask for example, and after it has acquired its due colour in this way, we may blow over it with a hair of bellow to force away any of the fumes of the acid, and we will find that when

we remove it from the fire after having treated it in this manner that upon cooling it retains its shining red colour. This preparation was formerly much admired as a medicine, but was found to be possessed of qualities too acrid, and it was attempted to diminish its acrimony by infusing in spirit of wine, but after all it always turned out a medicine of too great virulence for internal use. But it is every day applied externally in various cases with very great success.

It is a very curious substance on account of the variety of appearances it exhibits when precipitated from its solution in H_2O and from none of these more than the O_2 . If to a solution of it in this acid we add a Δ the Z precipitates of a brown colour or if we add lime ∇ to the solution a precipitate of the same colour is formed, and the more Δ the lime contains the darker will be the colour of the precipitate. This precipitate is applied to no purpose in medicine or in the arts. If to a solution of Z in the O_2 we add a V , a precipitate falls to the bottom w^h at first is grey but in a little appears perfectly black. This precipitate differs greatly from the former in some respects besides colour, the brown precipitate is a calx of the Z , but the black will be found upon examination, to be the metal in its metallic form and only reduced into minute particles, for the brown precipitate when rubbed on \odot does not affect it, whereas the black colours the \odot in the same way as running Z would have done. With regard to the cause of this phenomenon you will remember that from the experiments in a former

part of the course the δ appears to contain in its composition a quantity of Δ , and that some of the salts into whose composition it enters shew manifest signs of such a principle being present. One of these Ammoniacal Salts, the Nitro Ammoniac when exposed to heat deflagrates of itself. Therefore when I add the δ to the solution it is attracted by the χ , while the δ attracts from it the Δ and falls to the bottom not in its ordinary form, but in the form a fine powder of a black colour. This preparation has lately come into vogue, as it is one of the safest & mildest preparations of this mineral, all of the other preparations having a superior degree of acrimony. It is usual to give this medicine one grain for a dose, and it may be made into pills or continent with much less trouble than crude δ , and these compositions are ^{quite} active when newly made, & acquire no additional efficacy by keeping. It is by no means an expensive preparation, as it may be done in a very short time; it will only be necessary before it is precipitated to dilute the solution of the δ with perfectly pure ∇ , and to add to it as much δ as there is of δ dissolved. If I add to a solution of δ in the $\text{O}\chi$, some $\text{O}\chi$ the δ will separate from its solvent and unite with the $\text{O}\chi$; the same takes place when I add the $\text{O}\chi$; it shews that when freed of its Δ these two acids have a stronger attraction for it than the $\text{O}\chi$ has, but as this acid has the strongest attraction for Δ , it dissolves it when in its metallic form more

readily than either of them. The Ox forms with S a compound that is volatile by heat, and sublimes in the form of needle like fibres; this is called Corrosive Sublimate. The best way to prepare this substance is to take some vitriol of S and to grind it with an equal weight of common salt perfectly dry, to put this into a glass vial of w^{ch} it should fill about $\frac{2}{3}$, then place it in a sand bath when a decomposition will ensue, the S will unite with the Ox of the common salt and sublime to the top of the vial, while the S will unite wth the Ox and remain at the bottom in form of a glassy salt, this being a double elective attraction; then we break the vessel and collect the sublimate; so that in this way one could prepare as much corrosive sublimate as would serve their lifetime even tho they had a very extensive practice.

We may prepare corrosive sublimate by adding the Ox to a solution of S in the Ox , and then evaporating away the Ox . Corrosive sublimate was long thought to be poisonous in the smallest quantity, and indeed it is the most active of all the mercurial preparations, and is very destructive to animal life unless given in a very small dose, but a way has been found out to mitigate its violence by adding to it some running S ~~to it~~, nearly as much of the S as of the sublimate, to grind these well together till the mercurial globules disappear, and then to sublime it in a proper vessel; it is then found to be a very mild preparation, and is insoluble in water. This substance

is called Sweet sublimate or Calomel as we is a ridiculous name for it, as it is not black, but of a white colour. This preparation owes its mildness to the Hg° combining wth the corrosive sublimate without losing its Δ . It does not seem necessary to sublime it more than once if the ingredients are previously well grinded together & Dr. Probenok: who makes the most of the Calomel used in Britain told me that he did not find more than one sublimation necessary. It will be right however for practitioners to try the Calomel they purchase, if it is soluble in V° in w^{ch} case none but particles of corrosive sublimate that may be mixed with it will dissolve and all this may be separated, by washing every ounce of the Calomel by th two or three handfuls of boiling V° . Van Swieten was the first who ventured to give corrosive sublimate internally, and the form in w^{ch} he gave was 2 grains of it dissolved in Zij of brandy and a table spoonful to be taken for a dose, we now now begin wth 20 or 30 drops of this at a time and increase the dose gradually. That this was much esteemed in Van Swieten's time, yet when the whole I think is an uncertain medicine, and not so efficacious as some of the other mercurial preparations, and is more apt than any of them to hurt the constitution, and to make the hair fall off w^{ch} is an inconvenience that in practice we would wish to avoid. It is never given in

such quantity as to produce salivation, but only till a
 copper taste is felt in the mouth, and indeed some
 eminent authors are inclined to think that ζ does not
 cure by the evacuation it produces but by a specific pow-
 -er peculiar to itself, of destroying the activity of the vene-
 -real virus. Corrosive Sublimate is the most perfect
 Saline preparation of ζ and is entirely soluble in \vee ,
 tho' in a small proportion, and tho' diluted with ~~100~~
 400 times its weight of \vee , it gives the solution a bris-
 -sy taste. From this substance sundry precipitates
 are got w^{ch} differ from those formerly mentioned. That
 by a. S is brown, by lime \vee yellow, and by the ζ
 white; ~~If the precipitate~~ A mixture of lime \vee and
 corrosive sublimate is used in medicine under the name
 of the Aqua Phagedonica for washing foul ulcers. By
 the colour of these precipitates we can very readily dis-
 -cover the S , the DC , or ζ when we are doubtful of their
 nature of any body. The white precipitate also is
 used in medicine; and when we examine it we
 will find it to be nothing different from Calomel
 w^{ch} is a chemical fact the reason of w^{ch} is not per-
 -ceived at first sight. It is this, the ζ is not able
 to extract from the sublimate all its S , but it ex-
 -tracts part of it, and furnishes Δ to the sale of the

¶ so that this Precipitate is the same as if we had added Crude Φ to corrosive sublimated. It is said if Hefers pill is made by boiling the \ddagger upon this Precipitate —

Of the inflammable bodies Φ combines wth Ψ forming Aethiops Mineral w^{ch} is in form of a black powder and of all the preparations of Φ it is the mildest and most insipid, it is seemingly inactive in the body and is only employed as a vermifuge for w^{ch} purpose it may be used wth great safety. This substance is commonly made by grinding equal parts of Φ and Ψ together till the globules disappear and it succeeds best when the mortar is heated. If we mean to make an Aethiops wth 7 parts of Φ to 4 of Ψ we must then melt the Φ and stir it till it incorporates wth the Ψ . If we grind together 1 part of Ψ and 3 of Φ and expose them to heat in close vessels, they will sublime in form of a dark red compound called Cinnabar, w^{ch} on being leigated acquires a beautiful red colour and is then known to painters by the name of vermilion. Cinnabar is used in medicine and next to Aethiops is the mildest of the mercurial medicines; it has been employed when converted into vapour by heat to fumigate

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The preparations of Mercury are

I. Preparations in which the Mercury is only divided.

Emplastr. Mercuriale. Id. Empl. commun.
cum mercurio. Lond. Empl. ex Ammoniaco
cum mercurio. Lond.

Unguentum Mercuriale. Id. Ung. Cerul. fortius
et mitius Lond. Ceratum Mercuriale Lond.

Pilule Mercuriales. Id. Pil. Mercuriales. Lond.

Mercurius præcipitatus cinereus.

II. Mercury calined by heat and air.

Mercurius Calcinatus Lond. Formerly called
Mercurius præcipitatus haec.

III. Mercury reduced to the form of a salme compounded or cald by acids.

1. With the Vitriolic Acid.

Mercurius Flavors Vulgo Turpethum Minale
Id. Mercurius Emulsionis Flavors Lond.

2. With the Nitrous Acid.

Mercurius Corrosivo Ruber, Vulgo præcipitatus
ruba. Id. Mercur. Corros. Rubs. Lond. Improve-
ments upon which to fit it for internal use, have
been attempted in the following.

Mercurius corallinus. Lond.

Arcanum corallinum

Pulvis principis

Panacea Mercurii rubra

M.D.

3. With the Muriatic Acid.

Mercur. Sublim. fuscus. Ed. A. Lond.

Mer. precip. alb. Boerh.

Mercurius Dulcis. Ed. *Mercurius Sublimatus Dulcis* Lond. (called likewise *Aquila Alba* & *Calomel*. Improvements upon it have been attempted in the following.

Calomelors

Panacea Mercurii.

4 With Arsenic Acid

Thiopers Pill.

5. Precipitated from a solution of (corrosive) Sublimate by Alkali's

Mercur. precip. fuscus.

Mercurius precipitatus albus. Edin. A. Lond.

Unguentum e Mercurio precip. Lond.

IV Combined with Brimstone

Aethiops Mineralis Ed. A. Lond.

Cinnabaris fictitia Ed. A. Lond.

Aethiops Antimonialis. New Disp.

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places violently affected in the Venereal disease, and I think
it may be employed in this way with considerable advan-
tage. In the case of these two last preparations we have
a strong instance of the power of Φ in destroying the acti-
vity of Ψ . Ψ is found in the bowels of the earth in the form
and it is disputed whether this native, or the factitious
cinnabar $\pi\pi\pi$ that made by art / are the best, the fact is
they are both alike. It is found in the earth either in its
own form or that of Cinnabar. It is found in great quan-
tities in Spain and at Pruli in Italy; when in the form
of cinnabar it may be separated from its Φ by adding
a substance that has a stronger attraction for it than
the Φ has, and when exposing them to heat the Ψ distills
and is called Ψ revived from cinnabar. and is very pure.
The substance employed to attract the Φ is commonly
 Φ filings w^h by the by is the only metal that can be
used for this purpose, for tho' most of them have a stron-
ger attraction for Φ than Ψ has, yet there is none except
 Φ but will contract a union with Ψ . Almeda in Spain
they mix earthy matter with the Cinnabar to attract
the Φ . Cinnabar may be made by adding Ψ to a
solution of hepatic Sulphur and agitating the mixture
without sublimation. All the preparations of Ψ are
easily reduced into their metalline form, even the calx

of S when put into a retort and exposed to heat will come over in form of running S . —

The metallic substance next in order is Antimony or as it ought to be called.

Regulus of Antimony

Appears by every examination to be a very simple metallic body, but was much tortured by the alchemists, as it was by them supposed to contain some mystery for when it crystallises in a manner when it cools after being melted in great quantities, and exhibits on its surface the figure of a star. But this regularity of arrangement is not common to this body. It is allowed on all hands to belong to the class of semimetals as it is not possessed of ductility is volatile by heat, and when exposed for some time to a heat less than is sufficient to melt it, it calcines into a grey powder. If we put some of it into a vessel wth some aludel added to it, the antimony will sublime into the aludel in the form of flowers. If we take the grey calx of antimony and expose it to a strong heat in a crucible it will melt into a glass without addition, and the more the calx was calcined

before we melt it the more transparent and pure will the glass
 be, and the milder for medicinal purposes. This glass is
 used in medicine, it formerly was the practice to fashion it
 into the form of a cup, and to fill this with wine, and after
 allowing this to stand all night to drink the wine in the mor-
 ning. It was also customary to give the glass in substance
 fashioned into the form of a pill, but in both these ways it
 sometimes produced very violent effects, for you will easily
 perceive that the wine would dissolve more or less of the glass
 according to its degree of acidity, & the pill would be more
 or less active according to the ^{quantity} contents of the stomach were
 acid or not. So these were laid aside and more contain prepa-
 rations substituted in their place. Most acids dissolve this
 substance, but the fopile acids form wth it compounds too
 active to be ventured on internally, so that none but solu-
 tions of it in weak acids as that of wine, & of the hu-
 man stomach can be used. Most of the acids particu-
 larly the fopile ones do not act upon it in the heat
 of the air. The O requires to be brought in contact with
 it in a particular form, we must add the Ψ to a com-
 pound of the O and Φ that as the Ψ combines wth the Φ
 the Φ may attract its Δ . Accordingly when we add
 one part of Ψ to 2 parts of Corrosive sublimate, grind
 them first well together and expose them to heat in a
 retort, the Armony rises combined wth the O in form of
 a substance w^{ch} is fluid in a moderate heat, called the

Butter of Antimony, w^t is thick when cold, but is attenuated and rendered more pellucid by destilling it a second time. Another way of disposing Δ in the O is to pour upon it some aqua regia w^{ch} consists of two parts of O and one of Δ , in this case the O combines with the Δ and is dissipated in form of nitrous gas, while the O remains combined w^t the metallic part of the Antimony. The butter of antimony is the most corrosive and violent of all the antimonial preparations. If this is diluted with a quantity of Δ the antimony is precipitated in form of a white powder w^t is capable of producing very violent effects on the human body, and is ridiculously called mercurius Vitae, and ought never to be ventured on internally. This substance is easily acted upon by most of the acids, even the \ddagger dissolves much of it.

Δ by being melted 14 or 15 times with the addition of a \ddagger soluble S acquires a degree of ductility, and amalgamates w^t Δ w^h it would not do before. A great many of the preparations of antimony and some of those already mentioned are not made from the pure regulus, but from the ore of this metallic body, w^h is for the most part a mixture of Δ and antimony in equal proportions; tho' they might be prepared with most advantage from the pure Δ .

When the ore of Antimony is first dug out of the earth it is always found to be blended with some stony matter, from w^h it is freed by a particular process; by melting the antimony w^h is the most fusible of the two substances in a crucible w^h is

has several small holes drilled in its bottom which is placed into another crucible, and both of them set into a furnace, the lower one is kept cool by filling the bottom of the furnace up to the top of the lowermost crucible with ashes, while we fill the rest of the furnace with lighted coals, the Antimony as it is heated melts and falls by its gravity thro' the holes in the bottom of the crucible into the one beneath w^{ch} is kept cold by the ashes, w^{as} they are very rare transmit heat very slowly. Antimony was known to the Greeks and Roman Physicians, but was first examined by the alchymists, who found that in its crude state it contained a portion of Δ , it is used in curing the diseases of horses, when their skin is diseased by an obstructed perspiration, by restoring w^{ch} it makes their hair grow sleek, and a horse can take $\mathcal{Z}i$ of the glass of antimony in a day, if w^{ch} no person can with safety venture to take two grains.

The grey calx is the basis of the glass of antimony and the common way is to take crude antimony and roast away the Δ and to caline it by increasing the heat gradually, this calx when exposed to a strong heat in a crucible melts into a glass w^{ch} if the antimony was not well calined is of a yellow or reddish colour, but if it was perfectly calined it will be more transparent, the glass of antimony may be restored to its metalline form by melting with the black flux.

It is never given inwardly in substance, on account of the violence of its operation, a contrivance indeed was fallen upon by a surgeon in this country to add to it $\frac{1}{8}$ part of bees wax

and roasting it till the wax is burnt away, and a great many ^{cures} are attested to have been performed by this preparation in the Medical essays, but it is but a precarious medicine; and tho' there are a great number of preparations of antimony in every dispensatory, yet few of them are used as they are too uncertain. ^{Infus} Agila dissolves with great ease the metallic part of antimony; also when added to corrosive sublimate and caps. sid to heat the Crucibles with it and a butter of antimony distills, but instead of a running & being left behind as formerly when the pure ^{was} used, there remains an Aethiops mineral; from which if sublimed rises in form of Cinnabar, it is called the Cinnabar of antimony, but is nothing different from cinnabar made artificially. The greatest differences between the ^{and} crude Antimony occurs in the effects of alkaline and compound salts upon them. The preparations of it & alkaline salts are very numerous, and regard must chiefly be had to the quantity of the antimony used contains. The first of these preparations I shall mention is the

Regulus Antimonii Medicinalis

It is of a black colour and like the metal possesses a degree of lustre and it has even a glassy appearance, it is not easily understood from the way it is made. The process is to take ℥iv of Crude antimony and ℥i of S. & to melt them together in a crucible close covered up, now how it acquires the glassy appearance without being calcined is not perceived

readily at first sight. We must first consider that the antimony contains Δ which unites with the S forms a hepar w^t dissolves the metal, and as some of the Δ of the Δ is always escaping the Δ unites with the S and forms a vitriolated tartar, w^t is again decomposed by the Δ of the metal, so that by this method it is calcined, and acquires the shining glassy appearance. Another preparation of antimony is the

Pierres Mineral.

It is made by adding to Lb of crude antimony Lb of S and boiling them together for two hours, to sublimate the lighter while yet boiling hot and to allow it to stand and cool when there will separate from it during the cooling a red sediment w^t is the *Pierres mineral* and is much admired by the French, and is a very mild preparation. The

Sulphur Auratum Antimonii.

is very like to *Pierres mineral*, but contains no S the antimony being separated from a hepar sulphuris by the addition of an acid, the sulphur auratum also is not so mild in its operation as the *Pierres mineral*. The process is to boil together in a quantity of γ some caustic S and crude antimony till the metal is dissolved, to strain it while it is yet warm thro' a linnen cloth, and by adding a sufficient quantity of spirit of nitric diluted with its weight of water w^t will precipitate the Δ , w^t is to be carefully washed to free it from acrimony.

With regard to the effects of ϕ upon crude antimony, they are more violent than upon the γ on account of the Δ it contains; If equal parts of antimony and ϕ are mixed together

and set fire to, a deflagration ensues, and the antimony is by this process does not lose all its Δ remains blended with a vitriolated tartar, this is called *hepar antimonii*, but when the vitriolated tartar is washed away by repeated infusions of boiling water it is then called *Crocus Metallorum*. When we add so antimony as much O as will separate the whole of the Δ as 3 parts of O to one of antimony, there remains behind a *Diaphoretic antimonij* consisting of a calx of the mineral and a vitriolated tartar and when washed is an exceedingly mild preparation.

All these preparations are now laid aside, and only the *vitreum antimonii* almost is used in medicine, but it is not often used by itself but employed to make other preparations as the *Vinum Antimoniale* and *Tartar Emetic*.

When we want to get the Δ the best way is to take the gray calx of the mineral and fuse it with the black flux when we will get the *Regulus* perfectly pure. There is no preparation of it used in this Kingdom but the *Vitreum antimonii*, and the *Mercurius mineralis* is used in all other countries. The *Vinum Antimoniale* is made by pouring upon a quantity of the glass a quantity white Spanish wine and allowing it to stand till the glass subsides w^h happens in a day or two, and if we put up of the glass into a bottle and pour wine upon it it will serve for a century tho' we were to put fresh wine upon it every day. This preparation is used for emetic and sudorific operations. The *Tartar Emetic* is another way of separating the mineral, it has been prepared different ways

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The preparations of Antimony are,

I. Those in which The Antimony is only reduced to a fine powder.

Antimonium Preparatum. Ed. at Lond.

Tablettes de Hunchel. Monden.

II In which the cohesion of the brimstone and metal is diminished, and the last is therefore left more disposed to be affected by acids.

Rermes Mineralis.

Sulphur. Antimon. precip. Vulgo Sulph. Aur.

Ed. Sulphur Antimon precip. Lond
Pilula Atthiopiae Ed.

Atthiopia Mineralis. N.D.

Regulus Antim. Medicin. N.D.

Coccus Antimon. Medicin. N.D.

III. In which the brimstone is separated, but the metal is preserved on fire.

Regulus Antimonii

Regulus Antimonii Martialis.

IV. In which the brimstone is totally or mostly separated, and the metal itself is more or less calcined.

1. By Heat & Air

Vitrum Antimon. Ed. At Lond.

Vitrum Antimon. Corat. Ed.

Nix Antimonii.
(Focuo Antimonii). Lond.
(Focuo Antimon. Vulgo Focuo Metallorum).
Ed. *Focuo Antimon. Potus. Lond.*

Calx Antimon. Nitrata. Ed. James's powder.

Emeticonn mite Boerh.

Calx Antimon. Lond.

(Crusca Antimonii).

V. In which the metal is reduced to the
form of a Saline compound, or calx by acids
Fusillum Antimoniale Vulgo Bulph. Antim.

Ed. *Crusca Antimon. Lond.*

Mercurius Vitae.

Bezoardicum Minuale

Antimonium Saltharticum. N. Disp.

Tartarus Emeticus. Ed. A. Lond.

Vinum Antimoniale. Ed. A. Lond.

Preparations we have their Name from
Antimony, but do not contain any of
its metallic part.

Cinnabar. Antimon. Lond.

Tinct. Antimon. Lond.

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† The Tartar Emetic is often found
to vary in strength when made
in this manner; It might be
made of a more determined strength
by boiling Crystals of Tartar
along with The Mercurius Vitae
having previously separated the
marine acid from this salt
by a proper addition of dis
solved fixed alkali and after
ward washing it repeatedly
With warm water



many of us are uncertain. But what I think the most cer-
tain is to boil together the glass of antimony and crystals
of tartar and allow the whole to settle till the undissolved
antimony subsides, then pour off the solution and evaporate
it to dryness when you have the Tartar Emlic. †

It remains to mention a preparation of antimony w^o
has come into great vogue and w^h has done much good,
viz James's powder. By my analysis it appears
to be antimony calcined ^{more than the exogus metallum} but ~~not so much as the mercurius~~
~~vitalis~~ ^{less} than the Diaphoretic antimony, so that it is
weaker in its operation than the first, and stronger than
the last. In the Infirmary at Edinburgh as a succedaneum
to James's powder they used antimony roasted under a
muffle till the Δ it contained had escaped and it had put
on a calcined appearance, but it did not answer for some
times it had no effect when given to the quantity of twenty
five grains, whereas James's powder always produced its
effect in a dose of five grains. It had I propose towards
making it is to separate from the pure Δ a determined
quantity of Δ , and you will obtain a James's powder as cer-
tain as his own. Reduce the Δ to perfectly fine powder
and mix uniformly with it, from an equal quantity
to one and a half of O , thro' the whole into a crucible
red hot and when the deflagration is over remove it from
the fire; & I have found that when I used 3 parts of
 O to two of Δ , the preparation produced the effect of
James's powder in a dose of five or six grains.

Proceed next to . *

Bismuth

Or Singlase. It is very like to antimony is exceeding-
ly brittle and may be distinguished from antimony by its
density, its weight to Δ being as 9 to 1, and that of antimony
only as 7 to 1. It does not afford so many appearances
as Δ , it is only employed in some of the arts, and is one of
those bodies that cannot be deprived of all its Δ . It is very
fusible, melting at the 400 degree of the thermometer, and
is said to expand as it passes from a fluid to a solid form
but this I cannot aver but I know that in this state
it contracts less than any of the metals except those w^h ex-
-pand as they change from a fluid to a solid form. It is com-
-monly calcined by exposing it to heat, wth the concurrence of
air, but it never loses all its Δ . Its calx is very similar to
that of Δ , and melts along wth earths into glass as those of
 Δ do. When deflagrated wth O there is no light produced and
little of its Δ separated, and it cannot like Δ be reduced to
a red calx. When examine the effects of mixture on it we
find that it combines wth acids with difficulty and that
the OE only, dissolves it, and wth great violence as it does.

* With regard to the effects of E on metals, it has a weaker
attraction than any other substance for arsenic and will not amalga-
mate wth E easily. It unites with some of the metals however (and
is used in hardening) types when mixed wth Δ & Z , it also enters
into the composition of pewter. These are all its principle uses in this
branch

with this difference, that the stronger the Ox it dissolves
the bismuth the more easily; the Ox and Ox simple corrode
this mineral tho' heat be employed. The Ox dissolves less
bismuth than it does & as it will take up only one half of
its weight. If we add V to the solution of bismuth in the
 Ox , the metal is precipitated in form of a white powder it
is as pure a calc. of the metal as can be made, but it may
be melted by exposure to a red heat. This precipitate on
account of its colour is employed to give whiteness & softness
to the complexion, as a cosmetic it is known by the name
of pearl powder; tho' it is exceeding white yet it is apt
to change and become of a dark, or black on exposure to the rays
of the sun or flames from combustible bodies, or from fermenta-
tions; and to tinge the skin of a deeper hue than what
that of any European naturally is; hence persons who em-
ploy it ought to avoid ^{these} ~~it~~ I believe will be scarcely prac-
ticable as in towns, and public assemblies there is constant
ly fuel or combustibles burning, & I think that it would
be a laudable to forbear the use of it, as it brings on old age
before its time, and may even fall of performing a momentary
beauty by the circumstances mentioned. If the V we use for
making this precipitate be impure it will be a dirty white
colour. The Ox and Ox dissolve the pearl powder very rea-
dily. If we mix it with corrosive sublimate and expose it
to heat in close vessels there will distill a barysaceous sub-
stance and a running S . One salt has no effect on

this substance when by itself, but they precipitate it from
 its solution in acids, just as the addition of water does
 but if they contain Δ they tinge of a yellow colour. Com-
 pound salts have little effect on it. W^t regard to \square the
 substances, the calx of bismuth is a powerful flux for
 them, and makes them run into a glass. It forms w^t
 Δ a substance like to crude antimony w^t burns reddish on
 exposure to heat. It unites w^t all metallic bodies but too
 and it makes them flow thinner, and w^t a less degree of
 heat than they usually do; when mixed w^t κ and Δ the
 mixture flows very easily, and when cool is very hard,
 so that it would answer very well for the making of types.
 The two metals it does not mix w^t are ζ and Cobalt.
 Its most singular property is in its uniting w^t ζ and
 forming an amalgama w^t unites w^t and dissolves κ in
 a considerable quantity, while the compound retains a degree
 of fluidity almost as great as that of ζ , and this fluidity
 remains after the bismuth is thrown out in consequence
 of the compounds standing 2 or 3 days. When a little ^{Bismuth}
 is added to ζ it dissolves κ w^t the greatest ease, hence
 it has been proposed to use it to dissolve bullets in gun
 shot wounds, but it will be better to cut them out, unless
 they be lodged in the neighbourhood of great blood vessels or
 nerves, and in this case only we should employ the com-
 pound of bismuth & ζ . But even this way is not free of
 danger, as the suppuration may erode the vessels or

nerves & the mixing wth the granulations may destroy them
and bring on troublesome symptoms, so that it ought never
to be used where life can be preserved in any other way,
besides some situations of the wound will not admit of this
treatment as when the opening is from below upwards.
But I have been told that many surgeons have used
this wth great success when they dared ~~not~~ to use the
knife, but often there is no inconvenience proceeds from
the stay of a bullet in the wound and it works out by
its own gravity. Bismuth was long supposed to be a
fictitious metal, but now it is certain that it is a metal
sui generis and ores of it are found in different parts of
the world. Sometimes it is found in its metallic state
and sometimes in form of an ore wth $\frac{1}{4}$ or Cobalt. When it
is mineralised by Cobalt or arsenic the ore must be roas-
ted, the arsenic will fly off and leave the two in form of a
calx, the flame will restore the bismuth to its metallic
state, and the cobalt will remain in form of a calx. I come
to the next semimetal

INC

It has the same appearance and texture as the two
last metals, but its plates are rather smaller than theirs.
It is at the same time much less brittle, and not so easy
to reduce into powder as they are, and has more of a lead
cast than they have. It is not so dense as its specific gra-
vity both that of Δ being as 7 to 8, while that of Δ is as 12 to 1

It also does not like other metals, tarnish on exposure to the air, or when wetted. When it is exposed to heat it burns in a bright flame, and emits a white smoke, w^{ch} condenses into a white coloured cob web like mass w^{ch} is called the flowers of Zinc. It may be also be deprived of its Δ by exposure for some time to a degree of heat less than is sufficient to melt it, when no light will be produced, but the Δ will separate slowly from it, and by continuing the heat we may obtain a perfect calx of the metal. It seems then from the violence w^{ch} it parts wth its Δ when set fire to, to contain a great deal of it, w^{ch} as it may be separated by a degree of heat less than is sufficient to melt it, seems to be very slightly combined wth it. The ancient Chemists were of opinion that as they could not restore to the calx or flowers of Z to a metallic state, that it contained besides the Δ a mercurial principle. The reason why it is difficult to restore this calx to its metallic state is, that it would require to be exposed to so great a heat when in contact wth the black flux, as would be sufficient to make it burn in the open air, but if this process be performed in a retort wth a receiver half full of Δ luted to it, we may easily obtain it in a metallic form. This process succeeded perfectly wth Maury's but failed wth Newman, who used only $\frac{1}{4}$ of an ounce of the flowers in making the experiment, & his retort was not small enough so that it contained as much air as was sufficient to inflame the Z as soon as it received the Δ from the black flux, so that the flowers rose into the

293

necks of the retort to w^{ch} they adhered; but had he used Acunes
of the flowers, he would have succeeded, for in that case tho'
there is as much air in the retort as will inflame a little of
the Zc w^{ill} rise in the form of flowers into the neck of the
retort, yet as soon as the air is saturated wth Δ , the rest of the
 Zc will rise in a metallic form and destill into the receiver.
With regard to the effects of acids upon Zc , none of the metals are
so easily acted upon by χ as it is particularly by the fopile χ .
All of them dissolve it with violence, and combine with it ex-
ceedingly perfectly, and the solution is completely neutralized
so that no separation happens upon the addition of water,
not even by the addition of any other metal. The Oz unites
with it exceedingly readily, and wth great violence when diluted
wth its weight of water, as the salt formed by the χ and Zc has
very little solubility in water, so that when the Oz is not
diluted the salt crusts over the metal. This salt is called
vitriol of Zc or white vitriol. During the union of the Oz
wth Zc a quantity of elastic Δ ble air separates, w^{ch} if a piece
of lighted paper is brought near explodes wth great violence
at first when the bottle contains some common air, but after
the solution has gone on for some time the bottle is perfectly
filled wth this elastic fluid, and when the lighted is applied to
it, does not explode, but burns wth a bluish flame at the mouth
of the bottle where it comes in contact wth the external air. This
matter is exactly similar to the fire damp formed during
the union of the Oz wth Fe ; the formation of it is very easily
accounted for, the Oz uniting wth the Δ of the metal forms
a perfectly elastic substance w^{ch} is much less dense than

common air & always occupies the upper part of the vessel and in the mines it does the same, so that the miners get rid of it, sometimes by flat on their face and side by means of a candle fixed to a long pole. The Ox and Ox dissolve Zn dissolve Zn wth much the same phenomena as the Ox , only there is no inflammable matter separated during the solution.

I proceed to the next semimetal

Cobalt.

This Metallic substance has the property when exposed to heat wth some porax or Ox of melting into a glass of a beautiful blue colour, wth maybe made deeper or fainter by a mixture of other glass. This blue glass hath several names according to the condition wth it is in, when it is imperfectly fused it is called Zaffre, when fully vitrified it is called Smalt, & when finely levigated blue enamel wth is employed in painting, to blue tinnen, and to paint upon porcelain. In the making of blue glass Cobalt is chiefly useful in forming beautiful and lasting shades.

Cobalt dissolves slowly in all the acids, & the solutions have a red colour, it dissolves also in aqua regia. It furnishes nothing remarkable when combined wth any of them but the Ox , ⁱⁿ wth if we add it in a calx it dissolves and the solution acquires a rose colour. This solution is a sympathetic ink, and when put on paper acquires the colour of withered leaf, but on holding it to the fire, it changes to a green colour, but on removing it from the fire it assumes its original colour. This

solution has been very much admired, and many laborious processes were proposed in order to obtain it, but nothing is more easy all we have to do is to add the calx of Cobalt to the Or till it acquires a rose colour, and if we should add too much & we may remedy this by adding an α . The change of its colour when heated was at first thought difficult to be accounted for by the Chemists, but it is perfectly easy to be explained. The Or forms wth Cobalt a salt that is disposed to attract moisture from the air, this salt when freed of γ by holding it to the fire is of a redish colour, but as it is allowed to cool it attracts moisture from the air and resumes its original colour. Here is a piece of paper on w^{ch} is delineated wth this solution the figure of a tree; just now it is of a redish colour but upon heating it, it turns to a green, and on cooling becomes again red. This preparation answers very well for painting fire screens, & by the Or we may discover very small quantities of Cobalt as one grain of it will give a green colour to a great quantity of Or. Mon^r Beame thought that bismuth was preferable to Cobalt for making this sympathetic ink but it can only answer when it is mixed wth Cobalt. This substance furnishes nothing else remarkable, it possesses a strong attraction for aig^r, nigh as strong as γ . The parts of γ dissolve and the solution cannot be disunited but by decomposing the hepar. It unites wth all metals except γ and bismuth, and is said to render γ harder than it na-

turally is, it also renders I vastly more ductile, but it is so valuable that it is not employed for this purpose. It is found in great quantities in Germany, and in Scotland near Stirling. In this mine it appeared in form of rose coloured masses being mixed wth bismuth and the acid of w corrodes the bismuth. The next semimetallic body

Nickel

Has been but lately discovered, and the ore of it was first thought to contain Fe , but Cronstad^t shewed that it yielded a peculiar regulus wth he called the regulus of Nickel, and it is now found in Scotland as well as in Germany. It is totally destitute of ductility, is whitish, but when compared to V is of redish colour; it is 8 times and $\frac{1}{2}$ heavier than V , and its ore is often blended wth S and arsenic from w^{ch} it is separated with difficulty. It has not been applied to any useful purpose. It is of a plated texture, and requires a white heat to melt it. Its most distinguishing properties are most evident by mixing it wth acids, it dissolves in all of them and forms a solution of a deep green colour and is not precipitated by Z and even requires a great quantity of H to effect this. It dissolves in a solution of O and gives it a blue colour wth is not so beautiful as that of Fe in H of Sal ammoniac hence we may thus distinguish these substances

Compound Salts have very little effect on it. It has a stronger attraction for Δ than any known metal has hence it can be employed to separate this substance when combined wth any of them. It unites wth all metals except Γ and Δ , and it promotes union of Cobalt and Bismuth. It whitens Θ and Φ , the only property w^{ch} makes it valuable, is its attraction for Δ and repugnancy for Δ . These are the principal things w^{ch} regard to the Semimetals, the two last of w^{ch} have lately been added to the class.

I proceed now to the Metals properly so called these are divided into the Imperfect which can be deprived of their Δ by heat, and the Perfect metals w^{ch} withstand the strongest action of fire. The Imperfect are π , γ , δ , ϕ , the Perfect ν , θ and Platinum. I begin with the most imperfect of the first class

π

Is a very dense substance, but is the softest and easiest out of all the metals; however it is not ductile in any great degree, and does not stretch much under the hammer without cracking, hence mechanics chuse to melt it when they want it made into plates. It is the most unelastic of the metals, so emits little sound when struck. There are two ways of trying the ductility of a metal, 1 by hammering and 2 by

by stretching it into wire, this last is done by forming it into cylindrical rolls, and making it pass thro a hole in an iron plate, it is then passed thro a smaller hole, and after that thro one still smaller, till it becomes as small as it is possible to make it. It may be drawn into pretty small wire, but it is impossible to make it stretch considerably by hammering. When it is cast into organ pipes some Z is added to make it more sonorous. It melts of $^{\circ}$ of Fahrenheit's scale, and at a degree below this when beginning to freeze it has no cohesion betwixt its particles, so that if it is then strongly agitated it will be reduced into powder. If we take lead melted along wth orpiment* and pour it into an L vessel wth holes in its bottom, held over a bed of sand, it will run thro in form of lead shot if there is a proper degree of heat and a great quantity may thus be made in a short time. K when exposed to a pretty strong fire so as to melt it, gradually calcines, and if we raise the heat so as to melt the calx it flows with the appearance of oil, and when allowed to cool is of a scaly texture, and is easily broke down called litharge, of w^{ch} there are two kinds the one A is prepared in the refining of O and is called Lithargyrus aurii, the A and is of a yellow colour, the other is prepared in the refining of P from w^{ch} it gets the name of litharge of P and.

* Orpiment is a composition of A & S , see page.

differs from the Litharge of \odot in nothing but in having a white
cloud w^{ch} it owes to its containing a quantity of uncalcined
 κ in its metallis state. Calces of κ thus fused have got
the name of glass of κ by the French Chymists, but it has
not the distinguishing property of glass viz of breaking wth
a polished surface. The reason the French Chemists have given
it this name, is because the vessels used in France contain
a quantity of Silicious earth, so that the κ dissolves part of γ
and gets that glassy appearance. If the calx of lead be placed
in a furnace so as to have the smoky flame reverberated on
it, it changes first to a white then to a dirty red colour and
is then called masticote w^{ch} is used in painting, if it be ex-
posed for some time longer it changes to a bright red when
it is called Minium for red lead w^{ch} is used as a pigment.
The finest red lead for painting is made by exposing
ceruse to the flame when it first turns yellow and then of
a beautiful red: the Dutch make it from litharge, but the
Venetians who make the most beautiful kind of it, prepare
it from ceruse. The change that is thus induced, is per-
formed by the action of the smoky flame upon it, for if we
expose it in close vessels it suffers no change, but it succeeds
perfectly when it comes in contact wth the smoky flame, w^{ch}
should never be hotter than the melting point of the litharge
not indeed just so hot. Minium appears not to be so
much calcined as litharge, for if we give to the latter a
small portion of Δ it turns yellow, if we add more it be-
comes red, and if we add onore it assumes a metalline form.
By making it into red lead the calces of this metal gain

considerably in weight. Its increase of weight is owing to its attracting a quantity of air w^h is not first air but as pure as the air we breathe, and even purer than common atmospherical air, w^h may be easily proved, by easily proved by pulling it into a retort along wth some Ox , and placing the retort in a sand bath heated, wth its mouth placed below that of an inverted receiver filled wth water, and placed on the end of an inverted crucible below the surface of a vessel full of water; the Ox uniting wth the K will separate the air it contains, and it will rise out of the retort into the inverted receiver from w^h it will expell the V , and when we have thus got it, we can readily determine its purity. The calces of K are the most powerful fluxes when fused along wth silicious earths, they form crystals but they do not fuse uniformly together, hence this glass is not fit for optical experiments. This glass is more easily moulded into different shapes than any other kind of glass, hence it is most used for ornamental purposes, but some inconveniences arise from its softness, such as its being easily scratched; by exposing this glass in contact wth inflammable matter to a red heat we may restore the K it contains to its metalllic state, thus w^h we put a glass stopper into a crucible, surround it with charcoal dust and expose it to a strong fire the lead will acquire its metalllic form, without hurting the appearance of the glass any thing farther than making it opaque. Hence crystal is unfit for making retorts in w^h we intend to treat bodies chemically in order to give to them the Δ , so we must use black glass vessels for the purpose.

With regard to the effects of mixture upon κ , there is something peculiar w^t regard to the order of its attraction for ϕ . The common order in w^t they unite w^t metals is 1st ϕ , 2^d ϕ and 3^d ϕ , but they unite w^t κ thus ϕ ϕ ϕ . That κ is easily dissolved by the ϕ when diluted w^t the strong oil of vitriol does not act upon it, hence bleachers and dyers can keep it in leaden vessels, and it is prepared in vessels of the same metal contrived by D. Boerhaave. The ϕ forms w^t κ a substance w^t is insoluble in water, this is called vitriol of κ . If we add to a solution of κ in the ϕ or ϕ a little ϕ , or any compound salt that has the ϕ for its basis, a vitriol of κ precipitates, hence we can thus discover minute proportions of ϕ , or of κ . The ϕ diluted w^t twice its weight of ϕ dissolves κ very easily and the solution is at first yellowish, but as it cools it deposits yellowish crystals and becomes transparent; this salt has the property when melted in a crucible of detonating without addition on account of the Δ it contains. These crystals have a sweetish taste, w^t all the solutions of κ in acids have. Hunkel, Boyle & D^r Boerhaave that some of the κ when dissolved in ϕ was changed into ϕ a mistake w^t they probably fell into by using ϕ w^t had been employed to purify ϕ . The compound of ϕ and κ has been called ϕ of κ . If to the solution of κ in the ϕ we add some ϕ or salts containing it, the ϕ unites w^t the κ and falls to the bottom, forming a compound w^t possesses little solubility in ϕ called Saturnus Corneus or Plumbum Corneum. Most of the compounds of the

It and metals are called Cornea, from its forming with
D a substance that is of a tough horny texture called Luna
Cornea, but plumbum Corneum has none of the properties
of Luna Cornea. Both the Θ and Θ form compounds
with κ the first of w has no solubility in ν and the 2^d
has only a little, but they can easily be distinguished
for the Θ of κ will not dissolve in any quantity of ν
whereas the plumbum Corneum will dissolve if there is
plenty of ν added. An easy method of making plum-
bum Corneum is mentioned by M^r Maargraff, by adding
of calces of κ to of Sal ammoniac and exposing
the mixture, when the ν will rise and leave the Θ com-
bined with the κ . The \ddagger likewise dissolves κ , but
does it slowly, but this preparation of κ has been most
attended to of any. If κ be suspended over vinegar
kept in the heat raised by horse dung or tanners bark
for some days, its surface will be corroded into a
white substance called Ceruse, w is used in painting
it is called Flake ceruse from its Flaky texture being
the purest kind of it when prepared in this manner
as all the common ceruse is adulterated. If we add
ceruse to \ddagger it dissolves in it forming a salt of a
saccharine taste, w is used in great quantities in dy-
ing and painting, as also in medicine. This salt

is called Saccharum Saturni and when made from pure vinegar is perfectly white; but the crystals of the common thing prepared for the arts is of a dirty colour. If we dissolve Saccharum Saturni without addition we get a substance which has all the properties of spirit of wine except its smell, and it is easy to see how this happens as the $\frac{1}{2}$ A & V the component parts of the spirit of wine present. If we dissolve Litharge in $\frac{1}{2}$ we form the acetum lithargyrites, w^h when evaporated to a proper consistence is called Houlliard's extract. and when V and spirit of wine is added to it it goes under the name of Eau vegetable minérale or vegetable Mineral water w^h is used in gun shot wounds and suppurating tumours and may be imitated, by dissolving Saccharum Saturni in water wth the addition of some spirit of wine.

Saccharum Saturni does not dissolve wholly in water and even tho^t the water be distilled; it ought not therefore to be used as a test to determine the purity of this fluid, the solution of $\frac{1}{2}$ in the O^r is the one that should be used for this purpose. The calces of $\frac{1}{2}$ are very fusible in fusing wth bodies especially the silicious O^r but they do not so readily on any other particularly those of the argillaceous class. One species of the silicious earth itself is not so much as affected by the calces of $\frac{1}{2}$

This is the Jasper, as also the Spallum Scintillans, hence I have been led to think them not at bottom silicious carthos ~~but~~ & by a late publication of Mr Woodpe's it appears ~~that~~ they are argillaceous carthos, with a silicious appearance.

With regard to the effect of inflammable bodies upon π , I unite with it very readily, not only in its metallic form but when calcined, this compound acquires a very dark colour, and as it has something of a metallic cast it strikes a very sharp impression, it is used to take impressions from medals. The fumes of a hepar Sulphuris, have a remarkable effect in blackening the preparations of π , and will effect this thro' the medium of even 400 pages of a book, hence this is thought the basis of one of the most wonderful of the sympathetic inks. All we have to do is to write wth a solution of ZnO of Saccharum Saturni in Zn of π , upon a piece of paper, put this at the beginning of the book of 400 pages put a piece of paper moistened wth a solution of hepar sulphuris made by boiling lime & π together wth a quantity of water, and allow the book to lay for a day or two, and upon opening it we will find that the fumes of the hepar have reached the ~~top~~ writing and made it visible. Several other inflammable bodies unite wth π either in its metallic form or

when it is calcined. Viscuous oils form w^t it a tough ad-
hesive substance w^t is the basis of plaisters. This com-
pound is formed by boiling the ingredients together till the
t^r and oil are perfectly incorporated. During the boiling
it is necessary to stir the mixture incessantly to prevent
their burning, and as it is very difficult to keep the oil
and t^r in a proper degree of heat, it is found expedient to
put into the vessel along with them a good quantity of water
w^t as it cannot be heated above 212 keeps up a uniform
temperature, and keeps the composition from acquiring any
disadvantage from the violence of the heat. If the water
happen to be all evaporated before the whole of the t^r is
dissolved or the plaister acquired a proper consistence we
should be very cautious of adding more & till the compo-
sition has had time to cool by removing it from the fire; o-
therwise as its heat is greater than that of boiling water
it will occasion a considerable extravasation and explosion
tho' the & added be boiling hot. The more Δ the t^r used
contains the more adhesive will the plaister be, hence the
metal answers better than its calces for this purpose, but
it takes a much longer time to incorporate. It is sometimes
added to oils that have turned rancid in order to hide this
bad quality they have acquired, for the rancid part dissolves
the t^r very readily, but this is a dangerous practice, and
may be discouraged by the addition of a little \ddagger : w^t will make
the oil grow white and turbid. It is also mixed with lint-
seed oil to make it dry quickly for the purposes of painting.
With regard to the effects of t^r upon metallic bodies, it
unites with all of them except S, it has been said not to
combine w^t Fe, but I have found that it unites w^t it in a small

proportion. It is very seldom found in a pure or native state often it is found of a white appearance like ceruse, sometimes its ore has the appearance of free stone, sometimes it has the form of a transparent glass when it is called lead spar, as it has a sparry texture and breaks into rhomboidal pieces, but it has when in this state the Θ combined wth it. The most common form in w^{ch} it is found is in form of an ore mineralized by means of Δ or O , and of a rusty appearance, probably to some O in the bowels of the earth ~~mineralizing~~ tinging of that colour. The Sulphureous K ore is often of a blue colour, and its fibres run in different directions. In all these the process the K from its ore is very easy, the ore only requires to be thrown on the fire and roasted by w^{ch} means the O or Δ will be forced off, and the K will be converted to its metallic state and run to the bottom of the furnace. A great many of the ores of K contain nothing else but Δ , some of it contain only a trifling quantity others contain a greater proportion. Some of the K ores in Ireland contain 35 ounces of Δ in the ton, some contain 100 ounces in the ton, and this last is considered as an ore of Δ . The method of obtaining the Δ from the K is by scorification, the ore is laid on a scorificator made of bone ashes w^{ch} is very porous so that when the whole is exposed to a strong heat the K is reduced to a calx w^{ch} melts and is also lost by the scorificator as fast as it fuses, while the Δ being a perfect metal retains its Δ and is left perfectly pure on the top of the cupel & in a large lot they will often scorch ten tons in a weeks time. Another way of separating K from Δ is to convert

the metal into red π , so that by the same fire they make mi-
nium and purify the D at the same time.

It is a very unwholesome business to work any branch
of the manufactory of π ; it principally affects those who
smelt it from its ore who are rendered paralytic, and are
attacked wth a disease called the Mill Reek, it is attended
with an obstinate costiveness, till at last they lose the use
of their hands. The Old Remedy for this disease was cut-
ter swallowed evening and morning, but the proper one
is Mustard, as I know by the experience of a gentleman
who keeps a number of men at work at lead mills who
by the use of this Remedy are free from disease. The grinding
of ceruse is an unwholesome branch in the painting business
and may be remedied by the same medicine w^{ch} cures the Mill-
teak. All the preparations of π taken inwardly produce per-
nicious effects; when Saccharum Saturni is by mistake swal-
lowed it becomes necessary to expell it by vomit, and after-
wards to use some hot stimulating substance to expell any of
it that may have entered the system; for this purpose
the seeds of mustard entire are preferable to the mustard re-
duced to powder. So π produces bad effects when taken
internally, yet when applied externally if not in too great
quantity or too long continued it produces very good effects in
many diseases of π . The Next metal I come to consider is

4

Which every one knows is a D coloured metal harder and
less dense than lead is. It has commonly been reckoned the
least ductile of all the metals ~~and~~ but this is only true with
regard to forming it into wire, for it stretches better under

the hammer than Δ does, but cannot like it be drawn into wire; δ & δ Steel may be drawn out into very fine wire; but they cannot like Δ be stretched into plates of a good consistence, the reason is they possess a great degree of cohesion whereas Δ possesses a great degree of malleability but little cohesion. It melts at the 450 degree of the thermometer and if shaken while in fusion it falls into powder w^{ch} is used in medicine as a vermifuge, but I would imagine fine sand would be equally good. Some think that Δ derives its anthelmintic qualities from some ϕ it contains inseparably united with it, but this is so combined wth it as to shew none of its properties; of all anthelmintics there is none so effectual as Δ . Some think that worms are the cause of the disease w^{ch} accompanies them, but they are the effect of it, and by removing the disease we remove w^{ch} effect. When it is pure ϕ it is in a striated form, owing to the workmens beating it over the fire till it is almost melted, and striking it with a hammer when it falls into pieces of a striated texture. On being exposed to a degree of heat above its melting point it soon calcines into a white calx. This calx is the most refractory of all the metallis calces & contains no Δ ; it will not melt even in the focus of a burning glass along wth the strongest fluxes, when reduced to fine powder it is employed to make a white glass w^{ch} is very hard and strikes fire wth steel, and is commonly called white enamel; with this enamel they polish looking glasses and those for optical experiments.

When we examine it with regard to the effects of acids upon it we find that it does not dissolve easily in

any one of them, but if boiled in the strong O it is calcined
and part of it is dissolved and forms a salt w^{ch} is not used
for any purpose. The O acts violently upon it and re-
duces it to a white calx but does not dissolve it; it dis-
solves most readily in aqua regia, for which it has a
pretty strong attraction. This solution when evaporated
yields crystals w^{ch} are O , & it is found that 4 contains
10 parts of this semimetal. The solution of 4 in aqua
regia is very useful as it is used in the dyeing of scar-
let w^{ch} cochineal. The cloth is first boiled in a solu-
tion of crystals of 7, then it is boiled along with the
cochineal, and then ~~from~~ the solution of 4 in the aqua
regia is added to it w^{ch} fixes it of a bright scarlet co-
lour; in this case the solution O acts upon the cochi-
neal and changes it of a scarlet colour, rendering it at
the same time induble in water, changing it into
carmine, w^{ch} may be got by this process, or by taking
it from the hairings of scarlet cloth. This solution
of 4 of giving a bright lustre to all red colours in ge-
neral. The O dissolves 4, and during the solution
disagreeable vapours arise, and the solution when evapo-
rated yields crystals, but if kept it deposits a white
powder. If we mix thoroughly in a marble mortar
an amalgam of 4 composed of 3ii of 4 and 3iis of 8
with as much corrosive sublimate, and as soon as they are
thoroughly mixed, put it into a glass retort and expose
it to heat, having luted the receivers very close, the 4 will

come over combined with the strong O , it continually exhales a considerable quantity of white dense fumes when it has communication with the external air. There remains in the retort a quantity of S ; this combination of the O and S is known in Chemistry by the name of the Smoking Siquor of Libavius; a name derived from its quality and its inventor. If we add 1 lb of wine to this liquor and distill it in close vessels we will get a marine Aether. Vinegar tho' boiled in S vessels gets no bad qualities from it tho it dissolves a small quantity of the S . These are the principal things w^t regards to the effects of acids upon this M . As to the effects of Compound Salts upon it, Nitre deflagrates with it and converts it into a white calx, Sal ammoniac is partially decomposed by it.

Of the inflammable bodies, F forms w^t it a sulphureated S of a blue colour, when united in ^{proportion of 4 of F to 1 of S} ~~equal quantities~~. When more F is combined w^t S than can be united with it by melting them in a crucible, a compound of a yellow colour is formed called Aurum Musivum or Mosaic O .

The common method of making is to take of S , F , S and Sal Ammoniac each half a pound. grind these together and expose them to heat in a retort w^t a receiver luted on, part of the S unites w^t the F and comes over first in the form of the volatile tincture of F , then some liquor fumans Sibirici comes over, and then the S united with

some of the $\frac{1}{2}$ in form of Cinnabar, and the $\frac{1}{2}$ remains com-
bined with a great quantity of $\frac{1}{2}$ in form of Mosaiic O. In
this process most of the ingredients employed are lost.
There have been contrivances fallen upon to prevent this
Mr Wolfe directs to take sulphurated $\frac{1}{2}$ and mix it w
corrosive sublimate, when there distills a liquor fumans
Sibarii a cinnabar sublimes and an aurum Musivum
remains behind. The proportions of aurum Musivum
are 2 parts of $\frac{1}{2}$ to one of $\frac{1}{2}$ w^{is} more than can be com-
bined together in a crucible. This preparation is of a yel-
low colour, and is employed in coarse painting; it does
not dissolve in $\frac{1}{2}$, but is mixed up with oils for the pur-
poses of painting. $\frac{1}{2}$ combines wth all metals; it u-
nites with $\frac{1}{2}$ so closely as it cannot be separated from
it but by dissolving the $\frac{1}{2}$ in aqua regia, and allow the
 $\frac{1}{2}$ to crystallize. It debroys or impairs the ductility
of all metals except $\frac{1}{2}$. O and D have their ductility more
lessened by it than any other metal, and even the
fumes of it impair their ductility, so that if $\frac{1}{2}$ should
have been melted in a furnace, the furnace must be
pulled down and rebuilt wth new materials before O or D
can be melted in it. $\frac{1}{2}$ and $\frac{1}{2}$ in the proportion of 1
part of $\frac{1}{2}$ and 2 of fine $\frac{1}{2}$ form a composition very white
and shining, and so brittle as to break if let fall the height of
an inch from the table; this composition when cast into
a proper shape is used for making reflecting specula, hence it
is called speculum metal. This composition I think contains
too much $\frac{1}{2}$ w^h makes it so brittle, and I find that 3 parts of $\frac{1}{2}$

to one of 4 and were better. 4 melted wth 16 part of 24 forms a compound called Bronze w^h is used for casting cannon and statues. Another composition of 6 or 7 parts of 16 to one of 4 is called Bell metal. 4 is mixed wth K to make an inferior kind of pewster. With regard to its origin it is never as I heard of, and Cronstan also agrees with me ~~has~~ found in its metallic state but always in form of an ore, the great sources of it are in Europe at Cornwall; some of it is found in Bohemia and some in the East Indies, and always in form of an ore w^h constantly contains O sometimes $\frac{1}{4}$. Tho' it is the lightest of all metals, yet its ores are very dense on account of the O they contain. Not the miners are ^{very} uncertain of an ores containing 4 till they assay it, as many species of granite resemble them exactly. Its ore is frequently blended with stony matter, and is then called stream 4, as it can only be judged of by washing it with a stream of V. Black K is an ore of 4 mineralized by F and O, the coarsest kind of it is used for making crucibles, while the finer thing is valued for making pencils. If black lead is exposed under a muffle, it turns of a red colour, the F roasting away, and if we add to it the black flux we restore the 4 to its metallic state. The ores of 4 are mostly found in form of a garnet coloured stone and that of A at Cornwall has this appearance. To reduce 4 to its metallic state, the ore is first freed of stony matter by elutriation, it is then dried and thrown into a furnace where the F & O is roasted away, and by the addition of the black flux it assumes its metallic form, and runs into a vessel placed to receive it. These are the principal things w^h regard to 4. The next will take a considerable time so consider

♂

Is a metal w^h possesses very useful properties. It is not a very dense metal, but is very difficult to sever. When it is first smelted from its ore, it is very brittle and flies to pieces under the hammer, as it contains blended with some heterogeneous matter interspersed betwixt its parts, this is called Pig Iron. By melting it a second time it becomes purer, but still it possesses little malleability; if it be just heated red hot and hammered for a considerable time in all directions, so that its parts may be properly united and incorporated, and the heterogeneous matter separated, it will become as malleable as it is possible to make it, and is then called Forged ♂. It is the strongest of all metals except ♀; if we take an ♂ wire and one of ♀ both of $\frac{1}{10}$ of an inch diameter, we will find that they take near about the same weight to break them, and that they will bear a greater weight than any other metal will bear, hence ♂ is so useful in machines. When impregnated with a great quantity of Δ , it becomes very hard and brittle, and is then called Steel. In this state it is the hardest of all metals, hence it is formed into instruments for forming machines &c. of other metals; ♂ has some inconvenience of not being sufficiently ductile till it is heated very red hot.

♂ alone attracts and is attracted by the magnet, but when deprived of its Δ it loses this power, and the smallest particle of ♀ is sufficient to deprive it of its magnetic virtue. To make ♂ magnetical, all that is necessary is to rub two bars of it for some hours, strongly together, keeping them nearly in the direction of the meridian, when they will become strongly magnetical, but they lose it in a very short time if they

were not previously converted into steel by combining them with
a great quantity of Δ , when they will retain the magnetic
virtue a very long time. The magnet is an ore of this metal
& contains a great deal of Δ , hence its filings are used as
an ingredient in the composition for making spy rockets.
Though in its metallic state it is not easily fused yet on be-
ing strongly heated it acquires the consistence of waxpentine
when two bars of it may be joined together and incorpora-
ted by hammering them with great ease; and in this state
it can be occasionally fashioned into different shapes.
It alone strikes fire with flint, hence its use in fire arms
it owes this property to the great quantity of Δ it contains. The
method by w^{ch} it is effected is this, the flint by its hardness
strikes off from the steel, some particles of the metal w^{ch} does
with so much friction as to fire the Δ they contain, hence if we
collect the particles struck off from the flint we will find
them to be a true calx of the metal. Iron reduced into small
particles and kept for some exposed to a red heat gradually
calcines into a red coloured shry powder; all the calces of Fe are
called crocus and are ^{some of y^m} used in medicine, and are reckoned a-
stringent or aperient according to the degree of heat applied
during their calcination, but the truth of this is not fully
determined; it appears I believe that all of them have an
astringent, or tonic quality. It is very odd that a calx of
 Fe flows with greater ^{ease} than the metal itself, and it recovers
its Δ by being heated red hot in contact wth an inflammable
matter such as charcoal. These are the effects of heat
upon Fe ; but it is possible by overcharging it with Δ

to change it into steel w^{ch} is the hardest of the metallic bodies and by varying the quantity of Δ we convey to it, it acquires different degrees of hardness flexibility, elasticity &c. By cementing it with charcoal dust, i.e. putting it with alternate layers of charcoal dust in a crucible and keeping it in a red heat for a day or two, it takes up a great deal of Δ . Thus prepared it is called blistered steel, as there are some blisters on its surface owing to the action of some saline matter in the charcoal upon it. Steel thus prepared is too hard for most purposes but it may be made to possess different degrees of ductility &c. by laying it when polished upon a piece of red hot Φ till it acquires different colours, and then allowing to cool slowly. Thus on laying a piece of polished steel on a piece of red hot iron, it may be made to exhibit alternately all the colours of the rainbow becoming first pale, then red then blue &c. on. This change of colour can easily be accounted for, from the obvious and known properties of the rays of light reflected by bodies, the change of colour is owing to the film w^{ch} by the heat is formed on y^e surface of the steel gradually becoming thicker, thus when it is pale it is thinnest, and thickest when blue, and if the heat be continued it scales off all together. When steel is wanted of a certain degree of hardness for some materials, it is laid upon a piece of red hot Φ , till it acquires a brown colour, it is then not so brittle as blistered steel and is used for making hammers, anvils &c. if it be kept on the Φ till it turns of a gold or yellow colour, it is then of proper strength for files, saws &c. if heated till it becomes

purple it is then proper for razors, & other sharp instruments if till it turns blue, it is then very strong flexible and elastic, and is used for making springs of watches. Steel when allowed to cool slowly is of a stated texture when broke across, and is much harder than δ requiring more force to make it stretch under the hammer. If it is cooled suddenly by quenching it in cold water it acquires a granulated texture, and a degree of hardness superior to any other metallic body: in this form it scratches glass. If steel be cemented in a crucible along its bore & the burnt to whiteness, and be exposed to a red heat for some time, it loses its Δ in part and is changed into a very pure species of δ . It is thus they obtain the fine δ of which they make what isare improperly called steel buttons, at Birmingham. It is imagined that δ is increased in weight when converted into steel. I made a number of experiments to ascertain the certainty of this, and it seemingly increased a little in weight; but this increase was easily accounted for as some charcoal & sand adhered to the surface of the steel.

I come next to mention the effects of mixture upon δ . All fluids, even ∇ in some degree corrodes it, & if this could be prevented it would add to the utility of the metal. This may be prevented in some measure by dipping it in lime & sand allowing it to dry on it, this will prevent its rusting for some time. With regard to the effects of saline bodies upon this

metals. Every one of the acids acts upon it. The Θ when diluted wth water dissolves it very readily, during the solution a quantity of elastic matter escapes which is found to be inflammable, for upon holding a piece of lighted paper to the mouth of the vial in w^{ch} the solution is gone it takes fire and explodes wth violence like the fire damp in mines. The solution on being evaporated and allowed to cool yields crystals of a green colour, w^{ch} are called green Θ of Mars, or Copperas. This salt when exposed to heat quickly undergoes the watery fusion, and after all its Δ is evaporated it changes to a dark white colour & if the calcination be continued, its acid also flies off in vapours, when it gradually turns yellow, and as the heat is increased to a very strong degree it changes to a dark red colour, this is called Colcothar of vitriole.

The Θ also dissolves Φ forming a solution of a yellowish or dark brown colour as it is more or less saturated wth Φ ; this solution does not crystallize.

The Θ likewise forms wth Δ a green solution, and during the solution inflammable vapours arise. Aqua Regia also dissolves Φ . Φ has a stronger attraction for Δ than Φ or Δ . The \ddagger dissolves Φ but does it very slowly this solution is used in printing of cottons.

Alkaline Salts have very little effect on Φ unless they are kept in contact wth it for a long time but their principal use in this case is to precipitate it from its solution wth Δ . If a large quantity of Δ be added to a solution of Φ in

an & no precipitation appears but the solution retains its transparency. This is owing to the redundant part of the α used, acting upon and redissolving the δ as fast as it precipitates; but this experiment will succeed only when the α is fully saturated wth fixed air. But if we add just as much α as is barely sufficient to saturate the δ the δ will precipitate like any other metals. The solution of δ by an α is called Stahl's solution, and succeeds best when the α has combined with it plenty of fixed air when δ is precipitated from an acid by a δ it is of a greenish cast wth is soluble in α ; but if the solution of δ in an acid be kept for some time before the α is added to it, it precipitates of a brown colour. If we take an α mixture burnt and vaporated in a crucible all a blue flame appears; if we take a δ thus prepared and add it to a solution of δ in an α , instead of precipitating it in the form of a greenish coloured ochre, it falls to the bottom in form of a powder of a beautiful blue colour wth is insoluble in any acid. This precipitate is called Prussian Blue. The prepared α has always mixed with some α that has occasioned the action of the blood or glue during the preparation, wth precipitates some of the δ in form of a green ochrey powder wth mixing with the Prussian Blue destroys its colour, hence in

the manufacture of the Prussian blue they add some alum
the \square of w^e precipitating along wth the δ lessens the dirty
green colour of the assay part. Mr Macquer first gave
light upon this subject how the α should have the pro-
perty of giving the blue colour to the cala of the δ . He found
that the α by burning along with the blood or glue
combined with some principle by w^{ch} it was rendered in
a manner neutral, for the we pour as much α as we
please on it none of the prepared part will dissolve, but
when prepared α is added to a solution of δ in an α
a double elective attraction takes place, the α quits
the principle wherby it was neutralized, and joins wth
the δ while the δ attracts this principle w^{ch} gives it
the blue colour and deprives it of solubility in acids.
The acids have no effect upon Prussian blue, yet if
we infuse it in a solution of an α , the α attracts from
it the colouring matter, and does it most readily when in a
caustic state. The prepared α does not precipitate even \square
from their solution in acids, but it precipitates some metals in
form of a black powder. When employed to precipitate the δ from an
acid it is not of so beautiful a colour when it is first precipi-
tated; as some of the α is not properly prepared w^{ch} precipitates
a little of the δ of a green colour, w^{ch} mixing wth the Prussian blue
spoils its colour, but by adding an acid, w^e dissolve the δ
and the unprepared part of the α , the Prussian blue appears
in its peculiar beautiful colour. The only improvement now
made in the making of this blue, is during the precipitation to

add some lime, we preserve the colour of the precipitate. What is the substance that unites with the prepared Δ is not yet discovered; it has been thought to be the Δ ; but then a strong objection to this is that if this were true, any vegetable substance should do to prepare it with, and convey to it Δ . But for this purpose, nothing but the blood, glutin^{ous} skin &c. of animals will answer. Probably it is the δ that combines with it as Prussian blue yields a δ upon destillation. Prussian blue is now used in painting; it was at Berlin where the method of making it by accident was first discovered. A man in throwing out some things happened to empty together the contents of two phials, of one of the phials the contents was a solution of copperas, of the other a solution of prepared Δ ; surprised at the blue colour, he repeated the experiment, and found it answer perfectly. From that time the Prussian blue has become a principal article in some manufactures. It has been strongly inculcated by M^r Macquer to dye cloth with Prussian blue, who says it strikes a more beautiful blue, than indigo. The way of dyeing it is to dip the cloth first, all in a solution of copperas, and then into a solution of prepared Δ when it will acquire that beautiful colour, which is not affected by any acid; but then it is always spoiled by coming in contact with an Δ , hence it cannot be washed with soap, or any alkaline liquor. The prepared alkali is made use of to discover small proportions of δ , and if for this purpose we use an Δ prepared from glue, it will infallibly detect the most minute particle of δ where ever it is dissolved, by an acid, by changing it to a blue colour.

Besides alkaline salts, some other substances precipitate δ from its solution in acids; the juices of all astringent substances

precipitate it first of a purple colour w^h afterwards upon stand-
ing for some time turns black, & this also is a delicate way
of discovering small portions of Fe . Thus if we rub upon leather
w^h contains astringent matter imparted to it during the tanning
a solution of copperas it turns of a black colour. This proper-
ty of astringent substances constitutes the basis of the whole art
of dying black. The astringent substances employed for this pur-
pose are galls, and logwood, & w^h verdigrise is added to change the
purple colour of the logwood to a blue. Upon this principle pro-
ceeds the making of ink, w^h is done by taking 10 a quart
of Fe , four ounces of galls powdered, and two ounces of copper-
as, and adding to it after it has stood for 4 days or two some
Gum Arabic to make it ~~less~~ ^{apparey glossy} ~~solid~~ after being
wrote with, and to prevent the precipitation of any of the co-
louring matter. Some add some logwood w^h gives the ink a
more beautiful black colour, but it disposes the galls to separate
from the fluid in the form of clots. Cloves are generally added to
ink to prevent putrefaction, and the addition of 4 or 5 grams
of Zn hinders the growth of any vegetable matter in it.
We see then that there is a difference betwixt the Prussian
blue, & the Fe precipitated by astringent substances, the
one is soluble in acids, the other is not acted upon by them
hence by means of an acid we can take out from cloth
or paper stains of ink; and as all calxes of Fe are soluble
in acids, we can take iron moulds out of cloth by means of
these bodies. ~~When~~ During the dying of blacks the cloth
requires to be exposed sometimes to the air, hence the

dyers every hour spread it out and allow it to lay for some time and then return it to the kettle to undergo another boiling when it is again exposed to the air and so on. Whenever we suspect a vegetable of containing any thing astringent we have only to add to it a solution of O & it will change its colour black if it contains any astringent ~~matter~~. We can by this discover whether rum be good or not. The rum we is brought from Jamaica and other islands is all of it coloured by extracting the astringent matter from the casks we are made of oak; hence we add to them a solution of even a bit of O they acquire a black colour; while that rum we is coloured artificially wth burnt sugar retains its transparency when we add a solution of copperas to it. The black colour wth rum acquires by the addition of O , may be destroyed by the addition of some lemon juice wth dissolves the O and the fluid recovers its transparency.

With regard to the effects of ~~combustible~~ Salts upon O none but two of them produce any change upon this metal O added to it when red hot deflagrates wth it and reduces it to a calx. Sal Ammoniac added to it and exposed to heat is decomposed by it and the S rises wth the O in the form of a yellow sublimate called Flores Martiales. Calxes of O are used in the colouring of glass for painting upon glass and porcelain. It may be made to form a green, a blue, a red or a yellow colour by the different degrees of heat to wth it is exposed. The common dirty red

on some species of porcelain is made wth δ , but if it be too
long kept in the fire it turns yellow. Δ has a strong or
affection for δ than any other metallic body except Nickel
hence it may be used to separate Δ from other metals. The com-
-pound of Δ and δ is very easily fused; and if we rub a piece of Δ
upon a piece of δ red hot it ~~unites~~ the δ immediately flows
In like manner some metals when combined will flow much
easier than by themselves; thus by mixing 2 parts of bismuth
2 parts of Δ and one of δ we may compose a metal w^{ch}
will melt with the heat of boiling water. If we mix equal
quantities of δ filings and flowers of Δ and make them
into a paste with water and allow to stand for a day
or two the δ decomposes the Δ the Δ w^{ch} escapes and
mixing with the air produces a flame. So if we take
of flowers of Δ and δ of each 30 pound weight and make
them into a paste with δ and bury them under the earth
after a day or two they will produce an artificial earthquake
and eruption of flame. It has hence been thought that
earthquakes are produced by these bodies acting on one or
- another under the earth; but the extraordinary electrical ap-
-pearances that ~~are~~ accompany earthquakes would seem to
refute this opinion. Earthquakes ^{volcanoes} indeed may be occasioned
by these means near Mount Aetna or Vesuvius where these
materials so much abound. δ and Δ form a brassy colored
stone w^{ch} is found under the earth called the troch pyrites
it may be distinguished from the δ pyrites by its hardness

When the iron pyrites are exposed to the air a salt effloresces on their surface w^{ch} is a true Copperas; and all the copperas that is made near this town is made from this stone. It has a stronger attraction for acids than Z and V , hence if a piece of polished S be dip^d into the water of some springs w^{ch} contain Z , the Z is precipitated and adhering to the surface of S apparently converts it into Z . It unites very readily with all metals except K and P , & next to Fe it has the strongest attraction for S . With all these metals it forms nothing useful.

S is found sometimes in its metallic state but in very small quantities, the most common form in w^{ch} it is got is in that of an ore, from w^{ch} all the S used in the arts is obtained. There has no S as yet been found in the mines of South America. The ores of S are divided into two classes, 1st That w^{ch} is called the ore of S and 2nd Those species w^{ch} are called S stone. When it is found in veins then it is called S ore, and when it is got in large and extensive strata, it is then called iron stone.

S is only found in veins, and strata; that contained in veins viz the ores, are of a yellow, red & even blue colour, the iron stones are yellow, brown or redish. Sometimes it is found in form of a blue powder; here is some of this kind w^{ch} was found under Leastle Temple Dosh, after it was drained. The diamonds that are contained in slates are composed of S and of S . No ore of S can be wrought to advantage, but those w^{ch} contain little Fe or any thing else, the most common of them that are wrought is the haematites or blood stone; as also some of a blackish or brownish colour. Sometimes one species of ore w^{ch} ~~can~~ not be wrought

to advantage by itself, will turn out very well when mixed with some other species of O ore. The manner of obtaining O from its ore is very simple, the ore is first of all put into a furnace and kept there red hot for some time, by w^h means the Δ is roasted away and the ore rendered friable. It is then thrown into a furnace intensely heated being previously mixed with some quicklime to attract from it the Δ & left in it, the O receives the Δ from the fuel and runs to the bottom of the furnace, where it is collected and is then called pig iron, it is very brittle and void of ductility; thus it is made at Carron, where they find it necessary to mix together two species of O ore. Pig O contains always a quantity of \square mixed w^h it, w^h makes it very brittle and gives it something of the nature of glass, so that it will crack if suddenly heated or cooled. It is also sometimes ductile when cold, & brittle when heated, owing probably to its containing Fe ; other species of it are brittle when cold and ductile when heated, w^h perhaps contain some Δ . It may be converted into forged iron, by keeping it in a furnace in contact with charcoal red hot for some time and then hammering it in all directions. In large works O is forged with a hammer w^h is a ton in weight, and is worked by ∇ . O by forging loses half its weight. Beames thinks that this is why it loses, some of the Δ w^h it contained when in form of pig O , w^h last resembles steel, like it being brittle, and that the earthy particles that are contained in pig iron, are not dislodged by the hammering necessary to convert it into forged O . These are the principal things with regard to O the most useful of all the metals. —

♀

Is the most elastic and sonorous of the metals, it is the most ductile of any yet mentioned, whether we draw it into wire or beat it into leaves; but is not possessed of a great degree of hardness, so that it does not strike fire with steel, hence it is used for making chisels, hammers, hoops &c. in the manufactures for making gun powder. It is rather more ductile when it is hot than when it is cold, & it cannot like O be made harder by cementing wth charcoal dust. It requires less heat than O and more than any other metallic body to melt it, when in fusion it appears of a greenish colour very like melted O ; In this state there is a very great repulsion between it and V , so that if a little V shall have been thrown amongst it, or if the matter wth it is poured be not quite dry, the moisture being converted into vapour expands so prodigiously as to force the fused Z to a prodigious height, w^{ch} comes down in showers about the workmen and produces very fatal effects. There is one way of bringing melted Z in contact wth V without producing any explosion, by pouring it into a vessel of V in a very small stream, when it is collected at the bottom in form of little globules. Z while it melts absorbs a great quantity of heat, so that it requires a great quantity of V to take this heat out of it, hence we find that in granulating it, by pouring it in a minute stream into V , it reaches the bottom of the vessel in a fluid state. The granulation of Z lately found out has greatly facilitated the making of brass, w^{ch} is done by cementing Z with the ore of Z called calamine. If plates of Z be exposed to

a degree of heat that is not sufficient to melt it but to heat it red hot it calcines, into a greenish calx, w^{ch} cannot be made to melt by itself but in the focus of a burning glass. This calx is employed to give different colours to glass according to the degree of heat w^{ch} it is exposed, as blue red or green, and it is thus that in enamelling plants and trees are coloured. The calx of Fe melts very readily with vitreous materials, forming a glass w^{ch} must be reduced to powder when we intend to colour other glass. The green formed by it is extremely beautiful, and far superior to that w^{ch} can be formed by any other substance, but the blue and red are not so pretty. Fe is more readily corroded by O than any other metal, even V acts upon it. The O when in a pretty concentrated form dissolves it in a boiling heat, forming a solution w^{ch} yields crystals of a most beautiful blue colour called Roman or blue vitriol. This salt is contained in the waters of some springs; it may be made by exposing some plates of Fe and Z mixed together in a crucible to heat, when the O of the Z will act upon the Fe forming with it a blue vitriol. This salt was formerly used to get down proud flesh and to reduce the callous edges of ulcers, but it is very apt to spread farther than it should do, so that it is very unfit to be employed as an escharotic, & is now justly laid aside by all but the ferrugers. It is used in dying some colours. The O dissolves Fe with extreme effervescence, forming a green solution w^{ch} turns blue upon being kept. This

solution has been said to be incapable of crystallizing, but
 this is erroneous, and it readily yields crystals when the
 Q is dissolved in pure aquafortis. This salt is not ap-
 plied to any purpose, but it is reckoned curious, that it
 takes fire when scrapt up in a small quantity of A
 Thus I take a little of this salt w^t I bruise, and having
 moistened it a little I wrap it up ^{as} expeditiously by as pos-
 sible in a bit of tin foil, when after a little it bursts out
 into a flame with a crackling noise. The flame is owing
 to the A having a stronger attraction for the O than w^t
 Q , upon wetting the salt & bringing it in contact with
 the A a decomposition follows, the O unites with the A
 from w^t a quantity of Δ is detached, part of this Δ unites
 with the calx of the Q , the rest of it combines with the at-
 mospherical air producing a flame.

The O also dissolves Q , if we put into some of it a bit
 of Q and keep the whole in a dark place, it forms a yel-
 low solution, w^t upon exposure to the light turns green.
 This solution yields a salt w^t dissolves in V , and also in
 Spirit of wine, and this compound burns w^t a ^{blue} green flame.
 The solution of Q in O is not applied to any useful purpose.
 The \ddagger also dissolves Q forming a salt of a green colour
 called verdegris. The greatest manufactory of this is
 at Montpellier; there they moisten plates of Q with
 husks of wine grapes, w^t they allow to stand in pots
 till they are fermented, after w^t they are laid along with

copper plates in alternate strata; they are then set into a cellar for 2 or 3 days, when they are taken out and the rust corroded by the acid of the grapes scraped off, after w^{ch} they are moistened with ∇ and laid again alternately with the husks of the grapes to be again corroded. The Verdegris thus prepared is but a rust of the metal, but when dissolved in vinegar it crystallizes into transparent crystals. One would think that vinegar would answer as well as the acid of grapes for manifesting Verdegriis but they say that it does not do; perhaps it would answer if mixed with a little Spirit of wine. Crystallized Verdegriis yields upon distillation the strongest \ddagger that can be made. The \ddagger added to a solution of Φ in tan & precipitates it of a blue colour, & the \ddagger does the same, and if more of it be added than is sufficient to saturate the Φ & redissolves the Φ forming a solution of a beautiful violet colour, but the solution must be exposed to the light else this colour will not appear. A very minute proportion of Φ will give this colour to a solution of \ddagger , hence this salt is employed as a test to discover minute proportions of Φ . This colour may be made to appear and disappear by alternately adding some Φ and \ddagger . When the tincture is strong the blue colour is very deep. If to a solution of known Φ we add as much \ddagger as will precipitate the Φ , and evaporate the solution we get a blue coloured w^{ch} consists of a salt

formed by the δ and ϕ , and an ammoniacus Vitriolatus,
this compound is called Cuprum Ammoniacum it has
been employed medicinally, but it is unsafe to be used in-
ternally as it is so virulent. Nitre deflagrates wth ϕ .
Sal ammoniac is decomposed by it, and forms flores cupri.
The calces of ϕ melted with earthen form glasses of dif-
ferent colours as already mentioned. Absorbent earths
precipitate it from acids in form of blue or green Viriditas
but it is difficult to get this to succeed. ϕ unites with δ
and has near as strong an attraction for it, as it has for
 δ , it forms with it what is called copper pyrites w^{ch}
are extremely soft so that they can be cut with a knife
whereas the iron pyrites scratches glass. On the sur-
face of the copper pyrites a salt w^{ch} is a Pomum ϕ of
floresces, and from this source ^{probably} the waters of springs
get the blue ϕ they contain. ϕ cannot be separated ea-
sily from δ as it melts so easily and its \times acts on the δ .
Do draw a tincture from ϕ . All metals unite readily
with ϕ , δ attracts it most strongly; ϕ amalgamates
wth it when it is reduced to minute particles by being
precipitated from blue ϕ . ψ unites wth it and renders it
volatile. These two last compounds are applied to no
purpose. τ forms with it Brass pinchbeck or Princes
metal according to the proportion in w^{ch} it is united wth
it. For the making of brass it is necessary that the ϕ

be in as small particles as possible, & the Zc ought to be sa-
turated with Δ . The best way is to granulate the Z as for-
merly mentioned, and mix it with Sapis calaminaris and
charcoal dust, and expose the mixture in a crucible to a strong
heat which will melt the Z and Zc together into brass. Pech-
lee and Prince's metal contain more Zc than brass does
does, to make them the best way is to fuse brass with
the addition of a fresh quantity of Sapis calaminaris
 Z and Zc may be separated by heating the compound in-
tensely, till we will sublime the Zc in form of flowers, or
by adding to it while in fusion some Z we will unite wth
the Z and throw out the Zc . Z & Zc unite together. Z and Z
form Bell Metal, Specula of reflecting telescopes, or me-
tal for casting cannon according to the proportion in
w^{ch} they are united. It also unites wth S but wth it fur-
nishes nothing remarkable. These are the principal
things wth regard to Z ; I proceed now to the history
of its ores, and the manner of obtaining it from them
It is found more frequently in its mettallie state
and in more considerable masses than any metal
yet mentioned. It is supposed to be owing to its
melted from the substances wth it may be com-
bined by subterraneous fires. I have been told that

in one of the islands belonging to Russia called Kops-
 per island, it is found in the metallic state in prodigious masses; I have here the largest Specimen of it
 I ever saw. Most commonly it is found of a fibrous
 texture diffused thro' a quantity of stony matter
 at Gourock some of it is found in this form dif-
 fused thro' mossy ground. The most of the Fe used
 in arts is extracted from ores of a particular kind
 These may be divided into three classes. 1st Those
 found in form of a calx. 2^{dly} Those combined wth
 A ; and 3^{dly} Those that contain S . The first
 of these are more scarce than the two following, & are
 either of a blue or green colour according to the nature
 of the menstruum in w^{ch} they were formerly dissolved.
 Of the sulphureous Fe ores there are great numbers
 There is one of this kind in Galloway; it may be dis-
 tinguished from S ore by its softness. The most com-
 mon are those combined wth S , that have a dirty colour
 and appear redish or grey when we look narrowly
 at them, and w^{ch} always contain a minute propor-
 tion of S . These ores vary much in richness as
 well as appearance, they yield from 80 to 90 or 40
 percents. To these might ^{be added} the saline preparations

as blue vitriol w is sometimes found under the earth and
effloresces on the surface of the copper pyrites when they
are exposed to the air. The metal is easily got from
these ores. When it is in form of a calx, it may re-
duced by being thrown in contact with the fuel in
the large way of working, or in small by smelting
it in a crucible in contact with the black flux. The
arsenical ores are the principal ones, they require
first to have their arsenic roasted away, when they
may be reduced to their metallic state by coming in
contact with the fuel, or by melting in a crucible with
the black flux. It is difficult to roast away from sul-
phureous ores all their ϕ & w adheres to the metal &
greatly hurts its colour; it may however be freed of its
 ϕ by repeatedly roasting and fusing it. If it happens
besides to contain δ , then the operation is much more
difficult, it must be roasted & run down several times
then if you want to separate you must add t & w com-
bined readily with the ϕ and separates the δ & w swims
on the top from whence it may be taken off; and the
 t may be separated from the ϕ by heating, the com-
bined in a furnace the bottom of w is inclined con-
siderably to the horizon; as soon as it is heated a
little above the melting point of the t the t deliquesces
and runs down leaving the ϕ in form of a spongy

mass. In the same manner as we separate Φ from Ψ
we may separate Ψ but if the Ψ contains Θ the se-
paration is very difficult; but this I will mention when
I come to treat of Θ . When Ψ has been sufficiently pu-
rified, the workmen throw into the furnace wherein it is
melted a quantity of Δ in order to cool it; this they do
with the greatest safety as they wait till a crust is just
forming on its surface w^{ch} being thickened by the contact
of the Δ hinders the metal below it from exploding,
they then draw it out of the furnace by means of a
crooked iron rod, when it is called Rose Copper.

The Ψ in this country is very impure, it is chiefly got
in Cornwall. Scotland seems formerly to have yielded
very pure pure Ψ as is evident from their antient coin
but where it was got I know not. In Ireland they pro-
duce a very pure species of Ψ from the Pomona Θ got there
all they have to do is to add to it dissolved in Δ , some
 Δ w^{ch} precipitates it from the Δ , w^{ch} when melted along
wth fluxes furnishes a very pure species of Ψ , and pro-
bably it was thus the antient Scottish Ψ was obtained
but this is a mere conjecture.

a substance
imported from China possesses a degree of whiteness
nearly equal to that of Malina; it is besides the shon-
est metal known. It is a mixture of Ψ & Θ and Φ

but how they are mixed so as to give that degree of hardness I do not know; the principal ingredient is a mixture of P and S w^{ch} is brought from Japan and perhaps the whole secret consists in exposing this compound a long with alternate layers of *Lapis Calaminaris* as in the manufactory of brass.

I come now to the perfect metals, w^{ch} are three in number, viz. O , D and *Patina*.

The perfect metals possess all the properties of the imperfect ones, and besides many more, and are particularly more indestructible as they are not acted upon by the greatest violence of fire, or touched by the strongest solvents, either with, or without heat. The last of them viz. *Patina* was only first discovered three years ago, accordingly the characters given to the perfect metals will be found to apply chiefly to O & D .

They then in the 1st Place excel in Ductility all the other metals. 2^{dly} They resist the most violent and long continued heat without softening. 3^{dly} They do not decompose, nor are decomposed by Nitric, & Phlog. 4^{thly} They resist the scorifying power of K .

As to their first property O is possessed of greater ductility than any of them w^{ch} is plainly evinced in the art of beating it into leaf; where a piece of the bigness of a pin head is drawn three yards in length and then flattened an inch broad, and we have a still a better instance in the manufactory of gold lace where a grain is stretched to the length of 188 fath.

In the making the French laces, the extension is carried to a much farther degree, so that our imagination is lost in the conception, but it is all seen by the eye with the greatest ease. Of their 2^d property there are many proofs. Mr Boyle exposed \odot and ∇ to the fiercest heat of a glass house for a month and found that the \odot was nothing diminished in weight the ∇ had lost a little owing probably to its containing a little Φ . Even in the focus of a burning glass as lately tried by Mr Macquer \odot lost nothing in weight, some fumes arose from it by the violence of the heat, when being condensed, appeared to be some particles of the \odot unchanged. As to their 3^d property this is a property w^{ch} all the imperfect metals want, by the deflagrating power of this salt all of them lose their Δ hence by this method we can separate the perfect from the imperfect metals. From this property it has then been concluded that they contain no Δ ; but we can separate them from acid solvents by the addition of an ω , in form of a calx w^{ch} however is easily reduced to its metallic state, requiring only for that purpose to be melted along wth some saline matter. As to their 4th property, all the imperfect metals are vitrified when exposed to heat along wth ω , but the imperfect alone withstood the scorifying power of this metal when exposed along with it under a muffle & it is upon this the purification of the perfect metals depend, so that when they happen to be mixed with any other metal, they may be purified by subjecting the compound to scorification along with a quantity of ω . I proceed to treat of them in particular and shall take them in the order of their imperfection if you chose to call it so, first ∇ , \odot & last Φ .

D

The appearance of this metal when in its ordinary state is sufficiently well known, but it is not then pure as it is mixed with a proportion of one of the imperfect metals so that it is pretty hard, but when it is pure it is little harder than Fe. It resists the action of the air and moisture without rusting, but it tarnishes by being exposed to the fumes of putrid bodies, or of Φ . Thus when an egg is the least putrid it will tarnish a silver spoon, the same happens if it is exposed to the fumes of burning Φ . It has a great degree of ductility either when hot or cold, by hammering it it acquires a degree of ^{hardness} ~~hammering~~, to prevent which it becomes necessary during the hammering to heat it and allow it to cool slowly so as to quench it in cold Ψ .

All metals turn hard by hammering, w^h in some cases is very convenient, as by this means they can be hardened for some useful purposes. D after being melted, if it is allowed to cool suddenly when it is very pure is apt to vegetate, and small knobs to rise on its surface, owing the external film w^h is exposed to the external air, contracting upon the inner part w^h retains its fluidity and by the pressure hardening so that the melted part sprouts out in form of little knobs. The Θ dissolves D with the assistance of a strong heat during the solution some of the Φ flies off in a sulphureous form this solution is never almost prepared intentionally. The Θ is the one employ

employed to dissolve it, and does it with great ease, and
with the same appearance as when it dissolves Q. S.
dissolve D the O must be diluted with its weight of water
and we will find that $\frac{1}{2}$ of aquafortis will dissolve $\frac{1}{2}$ of D . During the solution permanent elastic vapours
arise; the solution of D if the metal is quite pure is per-
fectly transparent; also when the O used is not quite
pure at the beginning of the solution a white powder
falls to the bottom, owing the O containing mixed with
it some O , tho' it was prepared as carefully as possible.
This solution crystallizes readily into triangular plates
we are remarkable for their excessive bitter taste, if the \times be
fully saturated, and they tinge every thing they touch of
a black or brown colour, and this colour grows the deeper the
more it is exposed to the rays of light; this solution then
is the basis of all those nostrums used to change the di-
agreeable colour of the hair and for this purpose ought to be
diluted with 100 times its weight of water. It is also u-
sed to mark linnen while it is bleaching, for this purpose
it ought to be diluted with 30 times its weight of V .
It is also used to stain stones in imitation of agate ones.
but these are easily detected by throwing them into some
weak aquafortis. These crystals when exposed to a degree
of heat sufficient to melt them, & then thrown into
cylindrical moulds go by the name of Causticum Lunare
but in melting them great care must be taken that
the heat applied be not too strong. Lunar Caustic is

used by Surgeons as one of the strongest as well as perfect
corrodive, for fungous flesh; & it has this advantage that
it does not spread beyond its intended limits; it may also be
employed as an effectual styptic for stopping haemorrhages.
If we want to separate the O from V we have only to
expose the compound to a degree of heat sufficient to force
off the x . The O does not dissolve V as it forms a
Substance wth it that is insoluble in V , hence it only cor-
rodes its surface; but if we separate the O from common
salt in the form of red hot fumes it then acts upon V and
entirely dissolves it; this process is called Cementation the
 O is mixed with some O calcined to redness and, some brick
dust; this composition is laid in alternate layers, wth the
 V which is commonly mixed with O from which by this
process it is separated; the crucible is closely luted up and
covered with a smaller crucible; it requires after this to be
placed in a furnace and kept red hot for a number of hours
and when it cools we may take it out and separate the
 O from the cement w^{ch} is a compound of V and the O .
If you add to the solution of V in the O a little of
the O or any salt containing it, it separates the V
from the O uniting with it and forming a white pow-
der w^{ch} precipitates to the bottom and w^{ch} after being melted
becomes flexible and is therefore called Lima Cornea

This compound is very volatile and rises when below a red heat without separation, and when melted in a glass vessel it changes to a yellow colour. On the O having a stronger attraction for D than the O , depends the purification of this last mentioned salt; all that is requisite is to drop into the O we want to purify a solution of D in aqua fortis; the D will immediately be attracted by the O it is always contained in some proportion in the common O , and fall to the bottom in form of a luna cornea leaving the O combined wth nothing but a little D w^{ch} may be separated by distillation, when the O will rise leaving the D behind. Neither caustic nor mild S have any effect upon D , the S precipitates it from its solution in acids and afterwards dissolves it; Chalk also precipitates part of it but leaves a great deal suspended. The most common method of separating D from the O is by the addition of F w^{ch} has a stronger attraction for the O than the D has. For this purpose the solution is weakened by adding twice or thrice as much pure V . The vessel containing the solution is set in a sand bath and heated gently, and very clean plates of F put into it. The surfaces of the plates are gradually covered wth little white scales w^{ch} fall to

the bottom of the vessel as they are collected in quantities;
 As the aquafortis by degrees dissolves the Φ it parts with the
 Δ and therefore the liquid acquires a green colour as the
 solution advances. The addition of the Φ is to be continued
 till all the Δ is precipitated; it may be known to be the
 case when clean copper plates put in acquire no white or
 grey colour; and if a drop of Φ added produces no white
 cloud. Δ thus prepared may be reduced by melting it with
 some borax, but always contains a little Φ . The Φ may
 after this process be precipitated from the Φ in form of
 blue Verditer. Φ precipitates Δ from its solution in the Φ
 this precipitation is admired as it vegetates during its
 precipitation and assumes a ramified appearance if
 the Φ be added very gradually; this precipitate is called
 Arbor Dianae. Here you see it assumes a bushy rami-
 fied form. Δ is very difficult to separate from luna
 cornea, and this is one way of obtaining Δ perfectly
 pure as no other substance forms wth the Φ a compound
 insoluble in ∇ . One way of decomposing it is to mix
 it with flour or crystals of tartar, and to rub it on the
 surface of polished steel, on w^{ch} it will deposite a thin
 film of Δ w^{ch} may be scraped off. The method recom-
 mended by W. Haargraff is the best one; to take the

Luna Cornea and grind it with some D, it unites with it, and then when we add some Q to it, it readily unites with the D forming an amalgam; then by exposing the compound to heat, the Q rises leaving the D perfectly pure and requiring only to be melted with a little borax to reduce it to its metallic state. Another way of separating it is by a S, for this purpose the fofible S answers best. If we grind together two parts of Luna cornea, and one of fofible S, and put them in a crucible, & expose the whole to heat when the D is immediately detached. If we drop on some vitreous materials a little of the solution of D in the O₇, and melt the whole, the O₇ flies off while the D communicates to the glass a beautiful yellow colour if the heat is not too long continued, but even in this case the colour may be made to return by throwing some straw into the furnace, it will raise a smoke that will come in contact with the glass.

With regard to the effects of A on D no metal is so much affected by it; when united with this metal, the compound melts at a much less degree of heat than D does, and flows so remarkably thin as to penetrate any crucible. With regard to the effects of metals on D, it unites with all of them, and has its ductility by all of them except Q.

It has but a weak attraction for it, but deprives it of ductility. It destroys its ductility more than any other metal. It amalgamates with Hg , forming an amalgam which is heavier than the ingredients for composing it, it is very remarkable. As Q does not deprive it of ductility, it alone of all the metals is mixed with it intentionally, and as it gives it an additional degree of hardness, it is employed by all nations except the Chinese to alloy their silver coin and the quantity with which they are alloyed is regulated by the laws of the different countries. In Britain, the coin contains 12 parts of pure D alloyed with one of Q , and all the British coinage, or at least ought to contain this proportion; but as it is difficult to get the exact quantity, some small allowance is made to the master of the mint by the searchers. In France the coin contains 11 parts of D to 1 part of alloy, their coin therefore is not so valuable as ours, hence all of the British silver coin is carried out of the kingdom.

With regard to its origin it is found in great quantities in all countries either in its metallic form or in form of an ore; the American D is always found in its metallic form. When America was first discovered, the mines were very easily worked and yielded the D in considerable quantities, but at length they became very deep, and are now about to be given up, as they cannot be worked on account of.

The ores of Δ are very numerous, but it can never be got in form of a calx. It will not be necessary to mention all the ores of Δ ; it is a maxim with miners to call all ores silver ones when they silver they contain exceeds in value the other metalline substances. The most common are when it is combined wth Γ , or wth Γ and δ . We find it also combined with many other metals & sometimes in form of a Lima conca combined with δ . The Sulphureous and arsenical ores need only simple fusion, for the heat required to melt Δ forces away these substances; or when any other metal is joined with the Δ it may be scorified away wth κ . I come now to consider the properties of



called by preeminence Sol or *rea metallorum*. Its appearance when pure is perfectly well known, when pure it is softer than Δ and heavier than any known substance, being $19\frac{1}{3}$ heavier than ∇ . It is of a fine yellow durable colour w^{ch} is not injured by the fumes of putrid bodies, of Γ or of scowel. On looking at the gilding on public monuments, we see that it has retained its lustre for half a century, and that it loses this only by dirt adorning to it, so that if it is washed with spirit of wine, it recovers its colour by being washed with spirit of wine. It is the most ductile of all me-

metals as the process of beating it into leaf w^{ch} I will here describe evidently shows. Two ounces of O are beat with a hammer till they become as thin as paper, and it is rolled between steel rollers; it is then divided into 250 pieces each of which weigh $3\frac{2}{5}$ grains; these are again beat and put during the hammering are put between vellum leaves, so that they are beat very thin and each of them divided into 4 pieces: they are then laid between pieces of ox guts prepared and again hammered till they are six inches square; they are then divided each of them into four more and again beat to the ordinary size of gold leaf. The persons who make gold leaf find that it is remarkably affected by the weather and will not beat during frost unless the room is kept warm.

O when melted is of a bluish green colour, & expands much as it melts rising convex on its surface, and when it cools and turns solid it contracts greatly turning concave at its surface, hence it is very unfit for taking a sharp impression from any matter. When O is melted borax is added to it sometimes to make it flow more easily but as this salt turns the colour of the O pale nitre is sometimes preferred to borax. O appears by every trial to be indestructible, and resists even the solar rays collected in the focus of a burning glass. None of the acids in their pure state affect it, it has been alledged

that when boiled wth O₂ in a close vessel it will be taken
up but immediately on shaking the mixture the O se-
parates. Aqua Regia alone dissolves it with a moderate
degree of heat into a transparent yellow solution.
In this process the O combines only wth the O₂ of the
aqua Regia, the O₂ of w^h serves only to attract from
the metal its Δ , so that it prepares it for the action of
the O₂, according the solution of O in aqua Regia may
be called the solution of that metal in the O₂. Upon
distilling this solution there first comes over some O₂ then
some of the O₂, leaving the O combined with the O₂ in
form of a salt and perfectly dry. There are three ways
of precipitating O from its solution in the O₂, either by the
addition of an Δ , or by some of the inflammable bodies, or
by other metals. When O is precipitated by a δ the precipi-
tate is heavier than the O was before it was dissolved, and this
preparation has the property when gently heated of exploding
with great violence, hence it is called Aurum Fulminans
Dr Black thought that it owes its fulminating quality
to the fixt air communicated to it by the Δ , but I have refu-
ted this opinion w^h has prevailed till this same year by
an experiment, for I precipitated the O by the addition of
a caustic δ , when it was found to possess its fulminating
quality just in as great a degree as when precipitated by
a δ saturated wth fixt air, if it indeed seems strange
that so conclusive should have been overlooked by the Doctor

before he delivered his opinion of the matter. But it is easier
to object to theories, than to advance any thing satisfactory in
their stead. Probably the precipitate of \odot by the δ owes its ful-
minating quality, to some of the δ combining with it, w^h upon
exposure to heat, turns elastic and gives to the air that sharp
sound. & this is the more probable as *Curum fulminans* is de-
prived of this property by the addition of an acid. On account of
its fulminating quality this preparation is dangerous to
meddle with. Mr. Macquer tells a story w^h happened to his o-
perator who was engaged in preparing some of it, and in put-
ting the stopper into the vial in w^h it was contained, and tur-
ning it a little upon its axis, the friction raised a degree of
heat sufficient to make the preparation explode so that it
put out the persons eyes. The inflammable bodies w^h pre-
cipitate \odot from its solution in the \odot , are the Vitriolic
Aether, Spirit of wine and Et . If a small quantity of ae-
ther be added to a solution of \odot in the \odot , and the whole
shaken together, the \odot scales from the \odot , unites with
the Aether, and remains dissolved therein; the same decom-
position happens when we add V or Δ . The compound of
Aether and \odot is reckoned very curious as it consists of the hea-
viest solid combined with the lightest known fluid.

\odot may be separated from its solution in the \odot by many
of the metals. Also the saline preparations of δ do precipitate
it. Thus if we add to the solution green \oplus the δ attracts from
the \odot the \odot leaving the \odot w^h cannot act upon the precipitate
 γ also precipitates gold, if we add a solution of γ in aqua
regia, or put into the solution of \odot clean plates of γ the \odot
precipitates in form of a powder of a beautiful rose colour, which

is used to give this tinge in the enamelling of porcelain, and is known by the name of the purple calx of Cassius. Φ has no effect on \odot and Te alone of all the metals, hence the use of \odot in the touch hole of guns, and by this property of \odot not being acted upon by Φ we may separate all other metals from it except Te by taking advantage of the attraction of Φ for them but as Φ on account of its volatility in a small degree of heat is inconvenient for this purpose it has been found preferable to melt the compound of \odot and the other imperfect metals with a quantity of crude antimony, where the Φ being united with this semimetal is capable of enduring a pretty great degree of heat in this process the Φ unites with the metals we are mixed with the \odot , leaving the Te combined with the \odot , from w^{ch} it is easily freed by deflagrating the compound wth \odot . By deflagrating a composition of \odot and Te with \odot we may separate this semimetal. Tho' Φ has no effect upon \odot , yet the hepar of Φ dissolves this metal. If we heat a hepar in a crucible till it melts and throw into it small plates of \odot , the metal will dissolve very perfectly, and the compound is soluble in water; and very probably it was this way that Moses dissolved the golden calf as the nation of Joseph found in the Eastern countries found Φ an excellent hepar, so that by this means he could dissolve the golden calf, & render it soluble in V , so that all who had apostatized might drink thereof, as related in the book of Exodus. \odot may be separated from its solution in a hepar sulphuris by the addition of \odot or some other metal, or an acid. \odot very readily and easily combines with all metallic bodies & unites with it. Φ adheres very strongly to it, renders its colour white and makes it very brittle; hence it is employed to take

rings off the fingers when they are considerably swelled, and
 for this purpose it answers very well. If Z should have been
 put upon O accidentally, the O may be rendered pure by heating
 it near red hot we will force off the Z . If the O cannot conveniently
 be heated red hot, it may be touched with aquafortis we will
 dissolve the Z but cannot act upon the O . O may be made to a
 amalgamate with Z by throwing thin plates of it red hot into
 heated Z and stirring the mixture when the O will be dissolved.
 and any of the superfluous Z may be strained off thro' leather.
 This amalgama is soft when heated, and hard when it is
 cooled and the Z may be forced off by heating nearly red hot. With
 this amalgama the imperfect metals are gilded, such as
 watch wheels, cane heads &c. It is the easiest gilded of any
 of the metals and requires only to be rubbed with the amalgama
 to effect this; but this is not the case with brass, it requires
 first to be painted wth a solution of D in the O & then the amal-
 gama when rubbed on it readily gilds it. This way the wheels
 of watches are gilded which prevents them from rusting. If we
 want to gild P we must first paint it with a solution of Z
 in the O , we must then cover this with a coat of D and rub
 the amalgama of O above them all. The Z is apt to remain and
 hurt the gilding in its colour, to prevent w^{ch} they put on the gild-
 ing a solution of green O and heat it till it smokes and then
 thro' it into cold H . V forms with O a brittle mass. Bis-
 muth unites readily with O and is easily separated. On
 mixing Z with O and exposing the whole to heat the Z
 burns and rises into flowers we carry up some of the O with
 them and makes them have a purple colour. O & Z com-
 bined together form a brittle compound, it answers excellently

for making Specula of reflecting telescopes, for w^{ch} it answers
much better than the compound of U and F formerly mentioned
but it is a great deal too expensive. I unite readily with
 O if we stir O in fusion with an O rod the O will be dissolved by
the O . It is said that the compound of O and C makes excel-
lent Razors, w^{ch} are elastic, have a good edge and are not sub-
ject to rust. F acts upon O very differently, when combined
with that metal the compound is not brittle and melts with
a smaller degree of heat than O does, or even F . D & O united
together; the golden colour is diluted, and the compound is harder
and more sonorous than O . According a mixture of F & D
in equal proportions is employed to alloy O when it is made
into coin in all countries except China where they alloy
their gold coin with Silver. The only way of reckoning
the purity of O is the following. It is supposed to be divided
into 24 parts called carats, and gold that is perfectly pure
and free from all alloy is said to be twenty four carats fine
if it contains only 22 parts of pure O and two parts of
alloy it is then said to be 22 carats fine, and this is
the proportion of alloy the British O coin contains. The
French gold coin is only 21 carats fine, the Dutch Ducat
is 23 karats fine, & the Zekins of Venice are 23 $\frac{1}{2}$ Carats
fine. O may be separated from F by scorifying the com-
pound with tr and the D may be separated from O by per-
fectly pure aquafortis w^{ch} will dissolve all the D and leave
the O untouched, or it may be done as formerly mentioned by
cementation. These are all the remarks I have to
say concerning O . As to its origin it is always found

in its metallic form. Tho' it is the most valuable it is not
the scarcest of the metals. There is no river or rivulet almost
where it may not be got, but in so inconsiderable quan-
tities in most of them, as not to have the trouble of searching
for it. It is found in all the rivers in France; In Europe
the \odot found in the rivers is inconsiderable; it seems formerly
to have been found in some quantity ~~formerly~~ in the bottom
of some rivulet near Dead hills in Scotland among a stratum
of brown earth. In the rivers and mines of South America
there are great quantities of this metal; at first when this
country was discovered by the Spaniards the quantity of
 \odot found was immense. Opposite to California there was
lately found a piece weighing $\frac{7}{8}$ 132 and $\frac{1}{2}$ worth nearly
 $\$1530$. In most instances it is found in small particles
blended with sand & stony matter; in this case it is first
freed as perfectly as possible of the sand &c. by elutriation
it then amalgamated wth Hg and by exposing this com-
pound to heat the Hg rises leaving the \odot perfectly pure.
The last of the perfect metals is

Platina

Which derives its name from the Spanish word plata, that
signifies D . In the year 1763 some of it was brought into
England from Jamaica, and was very much admired as
it possessed many of the properties of \odot , and from its great
weight and D colour it was thought to be \odot some how
or other combined with D , but within these two or three
years it has been discovered to be a particular kind of metal

our generis, and possessed of properties w^e were thought to belong to \odot alone. It has only been found in South America. At 40 of Fahrenheit's thermometer its specific to that of \odot is as 18 to 1, while that of \odot is as 19 $\frac{1}{2}$; hence it was thought to contain \odot mixed wth it. Platina never melts by any degree of heat that can be excited in our furnaces even tho' it be raised to that degree so as to melt the furnace and crucibles into liquid glass. But Mess^{rs} Macquer and Became melted it in the focus of a burning glass. but no flux added will make it melt in our furnaces.

When melted it is exceedingly ductile, w^h properly it returns into its ordinary state. It may therefore be defined to be "a silver coloured metal; incapable of fusion in the furnace of the chemist; incapable of being calcined, and possessing a degree of specific gravity nearly equal to that of \odot " It is not acted upon by any of the acids in a pure state but like \odot dissolves only in aqua regia. Yet it differs from \odot in some trifling particulars. It is not dissolved in a heparsulphuric. It does not precipitate it from aqua regia in form of a purple colour, as it makes \odot ; & Vitriol of Aether, or E , do not precipitate it as they do \odot . Sal ammoniac precipitates Platina from aqua regia, but it does not produce this effect on \odot ; nor does the E precipitate a Platina fulminans: green \odot does not precipitate it from aqua regia, so that if we want to separate \odot from Platina, we have only to dissolve the compound in aqua regia, and add green \odot w^h will precipitate the \odot per se. This finished the 4th Class of the objects of Chemistry the metals.

WATER.

Many have written upon ∇ in a mechanical, but not in a Chemical view; it is a fluid that is very difficult to be got perfectly pure; it enters in a considerable proportion into the composition of every known substance, some of the ancients even were of opinion that it alone in different proportions composed the substance of every thing, but this is too extravagant. I formerly explained how it was raised into vapour by the heat of the solar rays, and condensed again by the cold of the night so as to come down in the form of dew, or of rain; I found what causes springs, and rivers derive their sources. The bodies into the composition of ∇ water are not only organized ones, viz. animal & vegetable bodies; it also enters into the composition of the hardest stones*, silicious even are to be obtained from certain springs. It has been imagined that during the general deluge, when this earth was totally overflowed with water, that by its action it gave occasion to the regular arrangement of the strata of the different bodies which compose the substance of this globe; but this argument is not well supported, and is indeed very improbable from many arguments I on a former occasion mentioned. It would seem that the extent of the ∇ in this globe is always decreasing, and hence we can account for the growth of ^{coral} ~~pearl~~ in the gulf of Mexico. Pure ∇ can only be got by distilling in clean glass vessels that have never been used, rain ∇ that has been collected at a distance from towns after it has previously rained for the space of half a day.

* The only substance from w^{ch} no ∇ can be obtained is ∇

Water thus purified appears to be "An elastic, incompressible
"fluid; transparent and colourless, & in a mean degree of heat
"betwixt that of summer and winter, its weight to air is as
"850 to 1; having its boiling point at $9^{\circ} 212$ of Fabren-
"heit's scale, & its freezing point at 32° . It has been
said that the purest distilled ∇ , is still impure for when it
is boiled in clean glass vessels till it is all evaporated it leaves
an earthy sediment, partly calcareous and partly silicious,
Boerhaave thinks that this substance left behind is dust
w^h was diffused thro' the water, but it is not inflammable
w^h properly dust always possesses. Sabotius thinks that
it is an earthy matter w^h the ∇ wears from the vessels.
Next to distilled ∇ in purity is rain water, or snow, w^h
two differ in nothing, except that the one is in a solid,
& the other in a fluid form. Even these are far from being
pure, for upon keeping them for some length of time they acquire
a degree of putrescence and acquire a green colour. Besides
they contain different substances, according to the purity
of the atmosphere through which they may have descended.
The air above towns is always loaded with dust, smoke
and the steams of putrid bodies, w^h w^h the rain w^h falls thro'
the atmosphere in these places must necessarily be impreg-
nated; the air in the country is more pure and often contains
nothing but dust, with w^h the rain that falls is always im-
pregnated, till after it has rained hard for a considerable time
when it has carried down all the dust &c, and the rain that

falls after this is as pure as it can be without desillation:
As rain falls, the air from all dust &c. that floats in it,
hence it is esteemed a purificator of that element, & hence the
air in the country is most agreeable after it has sojourned for
some time. Rain being disposed to fall on the tops of
eminences, sinks into the bowels of the earth, from whence
arise the origin of springs, the $\&$ of w^{ts} are impregnated
with the different substances, they meet, in their passage
thro' the earth. The waters of rivers contain fewer mineral
substances than those of springs do; as much of the waters
of the former run along the surface of the ground only with-
out sinking into it, untill that they arrive at their destined
channel. Mineral $\&$ or the waters of springs are gene-
rally divided into two kinds, sweet, & medicinal springs:
by sweet is meant springs the waters of w^{ts} are insipid to
the taste, w^{ts} however differ greatly with $\&$ regard to one another
with regard to the bodies they contain. The medicinal
springs are those whose $\&$ have some taste or other, and
are endowed wth some medicinal quality. Mineral waters
may contain dissolved any of the minerals mentioned in y^e
course of these lectures, & may be reduced to 9 general.
1. Those $\&$ that contain air. 2. Those that contain
pure acids. 3. Which contain pure $\&$. 4. Which contain
Compound salts. 5. Which contain earthy substances.
6. Which contain earthy salts. 7. Which contain inflam-
mable bodies. 8. Which contain Metallic salts. & lastly

These we contain Vegetable or Animal Substances. The
 1st of these genera, viz. these that contain air, are of two kinds.
 The 1st of these contains pure vital respirable air, which
 possesses a very great degree of purity. The other species of
 air contained in fixt air: the water thus impregnated
 has generally an acid taste, and possess a stinging quality
 like the waters of Piermont and Selzer, we are of this kind.
 When we would to examine what kind of air the water of any
 spring contains, we may try an empty bladder to the mouth
 of a spial filled with the water, & set this spial in among
 boiling water, we will separate from it the air it contains mak-
 ing it rise into the bladder which it will gradually distend
 and having thus got it by itself we can examine its nature.
 These waters are very agreeable, the Piermont spring con-
 tains only fixt air, the Selzer water contains besides a little
 O. The 2^d genus of mineral waters contain 4th. The only
 one that is almost sour contained is the Ot. This is easily
 distinguished from that which is made sour by fixt air
 this last loses its taste when heated, the other retaining it.
 The 3^d genus contains 2^d. & the only one they contain is
 the fopile d. The only well of this kind I know is near
 this town in Anderson in the middle, it contains a minute
 portion of fopile d. In Egypt the wells must contain a
 great deal of this salt. Near Vesuvius, the waters are

351

sometimes found to contain some S , communicated to them by
matter thrown during the inflammation from the Volcano's
of that mountain. The 4th genus contains Compounds
of Salts; the chief of these is O , of w^{ch} no spring almost is free
The well nearly opposite to the exchange in this town con-
tains a little Nitre; and Mr. Maargraff notes a similar one
in Berlin. Near Vesuvius the springs contain some Sal
Ammoniac. The 5th contains earthy substances, and the
principal of these is the C , of this kind is the petrifying
well at Wareborough, one in the wood of Hamilton, and
one at Woodsided. It is imagined that these V 's get this in-
gredient by the C being converted into lime, by subterrane-
ous fires, and so rendered soluble in V , and I shall not dispute
about this opinion. The 6th contain earthy salts, w^{ch} may
be reduced to the following; Gypsum salt, Epsom salt, Alum,
and the solution of the F C in the O , as also a minute propor-
tion of argillaceous earth. The 7th contain inflammable bodies
w^{ch} are H , the Sulphureous X , & bitumenous bodies. Sometimes
they contain a hepatic Sulphur. Some waters that are
sulphureous lose this quality on being boiled, these are only
impregnated with the fumes of sulphur. Bitumens only
float on the surface & are not properly contained in the
waters of springs. The 8th Species contain metallic salts
these they contain, are Blue O , green O , O of Zinc, and
 S dissolved by means of fixt air. The 9th contain
Vegetable and animal ~~matter~~ matter. River water is im-
pregnated with both these substances, and, Moss water

contains much vegetable matter.

If we evaporate any ∇ to a proper length, and if upon allowing it to cool crystals of a cubical or prismatic shape form in it; we may judge with probability approaching to certainty that it contains Θ or \bigcirc . But I will shew a number of experiments whereby in the space of 5 minutes you can be able to determine the purity & contents of any ∇ whatsoever. In examining the purity of ∇ , we first ascertain its density the purer it is the lighter it will be. I have here a glass ball when the thermometer stands at 56 , is of the same density as the purest distilled ∇ : that is if this ball be put into the purest water at the temperature of 56 it will remain wherever it is put, whether it be at the bottom the middle or at the surface of the fluid. In this drinking glass I have a quantity of ∇ which raises the thermometer placed into it to 56 upon putting the glass ball into it, I find that it is not so dense as the ∇ , and therefore swims upon its surface. I therefore warm the water a little by applying my hand to the glass, and I find that when I have heated it so that it raises the thermometer to 57 , that then it is of the same density as pure distilled ∇ ; which shews it to be a very pure kind of ∇ , as it requires to be heated only one degree more than the purest distilled ∇ , for at this temperature the glass ball will remain in whatever place it is put in the fluid. I shew it of the same density. Indeed it is the purest spring ∇ I ever saw; it is the ∇ of the Cistern at the head of the green at the river side. To become of the same density as pure distilled ∇ , the water of the river / Clyde / requires to be heated

to 58; the Dean side well and Lady well are next in degree of purity; the well in the middle of the Salt market requires to be heated to 68; the well at the foot of the same street, to 70; & the well above the Cross, which is the worst in town requires to be heated to 78. The impurities of ∇ may be owing to the presence of some saline matter, but it is oftenest occasioned by the presence of earthy salts. The quantity of these bodies that is contained in ∇ , may be judged of by the degree of muddiness produced by the addition of a solution of δ . Upon dropping a little solution of a caustic δ into the water of the cistern at the arms you see that the fluid retains its transparency, and therefore contains no earthy salt. The Dean side water or Lady well ∇ , deposits a small cloud; the impure ∇ of the well above the Cross deposits a prodigious large cloud, and the water of the well above Rushington bridge called the Physic well deposits, a green sediment upon the addition of the alkaline solution: this sediment is a scale of δ which metal it contains dissolved in it. The arms water is very soft, that is breaks soap, the best of any ∇ about this town next to it in point of softness is the water of the river and so on in progression according to their purity. Now suppose we want to know the nature of the earthy salt; we examine the precipitate, and accordingly we find, that the Dean side and the well above the Cross contain a compound of the Θ and \square viz a gypsum; the Θ of w combines with the δ added leaving the \square precipitated to the bottom of the vessel. The Arms ∇ contains a little Θ , for upon adding to it a solution of δ in the Θ a white powder falls to the bottom which is a true *Sinæ corneæ*. Upon ^{adding} a solution of δ in the

O^{to} to the arms ^{no} precipitate falls, but when this solution is ad-
 ded to the ∇ of the Lady well it becomes cloudy as it contains
 some O^{it} it unites with ∇ forming a Θ of ∇ , a salt w^h is
 insoluble in ∇ . The Physic well contains no acid, but
 its O^{is} is dissolved by means of fixt air; hence when this ∇
 has been some time exposed to the air, it loses this fixt air and
 the O^{precipitates} in form of a redish ochrey powder; and hence
 the sides of the streams which lead from this well are lined wth
 this ochrey substance. If a ∇ be a sulphureous one, we know
 the certainty of this by putting a piece of D, a shilling for in-
 stance into it when it will be coloured black: if the ∇ contains
 F. When a spring contains O^{it}, it may be known by adding
 an infusion of galls, w^h will change it to a black colour if any
 O^{be contained} in it; from the known property w^h this metal
 has of changing the infusions of astringent substances to a
 black colour. The presence of F in ∇ may be detected by the
 addition of a S, w^h will change its colour to a blue. The pre-
 sence of animal or vegetable matter in ∇ , may be discovered
 by the addition of some Luna Cornea w^h will be tinged of a deep
 brown colour. If we suspect an \mathcal{L} to be contained in ∇
 which is often but in a very small quantity; we therefore
 evaporate a good quantity of the ∇ , and if the residuum con-
 tain any \mathcal{L} it will tinge the blue infusion of the violet to a
 green; and afterwards we may know of what kind the \mathcal{L}
 is, by adding it to the solution of F in the O^{it}, when the colour
 of the precipitate will determine the genus of the alkali con-
 tained in the water.

I proceed to the next of the elastic fluids viz. Air.

AIR.

You will perceive that we have already exhausted the history of the different species of that elastic fluid air. They are divided into two classes, Simple & Compound.

The Simple elastic fluids are, common pure Atmospheric air, and the caustic &c. The Compound elastic fluids are, Fixt air, Sulphureous vitriolic air, Nitrous gas, Muriatic gas, & Inflammable gas, w^h is the fire damp of the miners.

Other species of compound air are mentioned in authors but they are reducible to one, or other of the classes I have mentioned.

Putrid air is a mixture of fixt air and some elastic inflammable air that arises from putrefying bodies, & this species of air is more dangerous to animal life than even fixt air. Also in analysing vegetables by means of heat in close vessels, there arises some elastic matter which consists partly of fixt and partly of inflammable air. Perhaps there is a very great variety of inflammable air and I am not so clear about it, as any of the former, as it can be got from many different substances. Thame's water yields a quantity of this air, when kept for some time, upon taking out the bung from the barrel, a quantity of air rushes out w^h takes fire if a candle is brought near it. It is said that air saturated with the & is inflammable: w^h if it is true we will be at no loss in this case to understand the great varieties of inflammable air and to know to what class they may be referred.

I come next to consider the properties of vegetable and animal substances. I have already explained a great number of their qualities in the former parts of the course, chiefly when speaking vegetable acids, Spirits, oils, & so that little remains to be added. They are of a more compound structure than unorganized bodies; are capable of propagating their species, are subject to a gradual enlargement and growth; arrive at maturity and proceed to a subsequent Decay.

The Organization of

VEGETABLES,

is more simple than that of Animals, but we find like them they are furnished with a variety of vessels for receiving, transmitting and perspiring different fluids. That these vessels are differently constructed in different plants, so that the nourishment they imbibe from the soil is changed into juices peculiar to different vegetables. There is no way of preparing these juices artificially. The same soil and seemingly the same matter is capable of producing poisonous and wholesome, as well as sweet and bitter plants. The same plant differs in its properties according to the soil, climate, season &c. in which it is reared, and it is from wild plants alone we can deduce a rational method of culture; all plants grow wild somewhere and it is the business of art to imitate their natural climate, by applying to them their just proportions of Air, V, heat & light, that in their natural wild state agrees best with them. Different plants are peculiar to different soils, the clayey, sandy & chalybeate soils, and these soils in black animal or vegetable

mould is predominant, each of them produce plants peculiarly adapted to their own nature, in the greatest perfection, but these plants degenerate or perish altogether when removed to any other soil but their native one. It is probable that vegetables are in a great degree nourished by calcareous gas and by the matter proceeding from putrid animal & vegetable bodies, hence we account for the fertilizing the soil by the addition of DC dung &c. But besides the air and matter transmitted to vegetables by these bodies along wth the necessary quantity of Δ that enters their composition the concurrence of another principle is absolutely necessary, viz^t the rays of light, w^{ch} independent of heat seems to affect vegetables in a manner as yet inexplicable, for without the concurrence of this body plants indeed may grow and increase in size but they will be void of their natural colour, have no smell or taste, & totally inflammable. It would then appear that different plants owe all their useful properties ^{to them} w^{ch} they contain, w^{ch} Δ it would seem they attract from the rays of light in an unknown manner, & that from the vegetable the Δ passes into the composition of the animal kingdom. It appears by experiment that none of the earth of the soil enters into the composition of the vegetables reared in it.

For if we take a sufficient quantity of earth; dry it and weigh it carefully; then plant in it the seed of a vegetable water it properly and expose it to the rays of the sun. The vegetable in process of time may grow to an enormous size perhaps it may weigh 30 or 40 pound weight. When it

has acquired this size, remove it from and carefully dry the earth we will be found to weigh exactly as before it had produced so large a vegetable. Now by this experiment it appears that the earth in this case was merely passive and that one particle of it entered into the composition of the vegetable. But altho' I said it was passive I did not say it was useless for it served to convey to the plant ∇ and air. Query. How come vegetables to get that \square w^h they contain in their composition in no small quantity? As there exists originally in the seed of the plant some earthy particles, these possess the power of multiplying and propagating the earthy parts of the vegetable without taking up any of the surrounding earth.

These 4 elements air, ∇ , Δ , & \square make the component parts of the vegetable kingdom as is clearly demonstrated by Chemical analysis by w^h we learn, that the elements of one plant differ in nothing from those of another in quality, but in their proportion in w^h they are contained in different vegetables; and that they are the same in the sweet sugar cane and bitter gentian; in the harmless corn and poisonous hemlock.

The component parts of vegetables may be reduced to 7 in number 1. Woody fibres. 2 Gums. 3 Aromatic oils or Resins w^h differ from one another only in consistence 4 Unctuous oils. 5 Saline Substances, 6 Sugar. & 7 Farnal.

1st The Woody fibres are the vessels thro w^h vegetables receive

the ∇ & by which they are nourished. These fibres are closely compacted in the trunk, but divided and separated in the leaves of the vegetable. That the woody fibres in the root and trunk are continued into the leaves, is proved by inverting the willow tree & placing its stem in the ground, When the root will send forth branches, and the trunk will send forth roots. The woody fibres of vegetables are most evident in paper where they are free from every thing close.

2^d Gum, the properties of these have been already mentioned they are insipid, inodorous, soluble in ∇ not soluble in spirits or oils, not volatile in the heat of boiling ∇ , infusible by heat & unflammable.

3^d Aromatic oils we are odorous, soluble in spirit of wine volatile at 212° ; ^{inflammable} they communicate their odour and properties to ∇ ; they contain in their composition the odour and often the taste of the vegetables from whence they are produced. By keeping for some time they turn of a solid consistence lose much of their odour, but still they retain their property of being inflammable, & solubility in spirit of wine: in this state they are called resins, when being distilled yield a thin oil. A. Unctuous oils, we are unctuous to the touch, inflammable, not volatile at 212° , incapable of mixture with ∇ , or of being dissolved in spirit of wine.

4th Are Saline Substances, we are endowed with taste and solubility in ∇ ; Many plants naturally contain an acid salt such as sorrel, &c, while plants that naturally contain no salt, yield salts of different kinds casually absorbed from the soil in w^{ch} they were raised, such as \bigcirc .

Nitricated Γ , Nitrous ammoniac and Θ . Θ is Sugar we is
a neutral kind of salt, of a sweet taste, inflammable, so-
luble in ∇ , and differing from most salts in being soluble
in spirit of wine. The Γ & last is the Lignin of veg-
tables w^{ch} is perfectly white, absorbs ∇ , rendering it tenacious
Starch we is the pure farinaceous part of vegetables, possesses
all these properties. There are different ways of operating
upon vegetables to obtain their active ingredients from
the other inactive parts with w^{ch} they are combined; an extract
may be made from them by squeezing out their juice and
evaporating it to a proper consistence. In this way we
get all the ingredients of the vegetable except the inactive parts
we are more gross, mixed together; but when we separate the
resinous, gummy, and saline particles by themselves then we
are said to analyze the vegetable. A way formerly prac-
tised was to analyze vegetables in close vessels exposed to a
naked fire, but this method is not now practised, as it totally
destroys & changes their properties by the violence of the heat.
Vegetables are now analyzed by infusing or boiling them in
 ∇ or spirit of wine, by w^{ch} means we get separately their
gummy or saline, their resinous or saccharine parts.
The colouring particles of vegetables according as they are
Resinous, gummy or gummi-resinous, are extracted by suit-
able menstrua and applied to numerous purposes in
the arts of dying &c. Some colours are of the gummy

kind, we may be extracted by means of ∇ , cloth dyed with these colours loses its colour by washing unless something be added to deprive the colouring matter of solubility in ∇ and to fix it in the cloth, such a substance is called in French *Mordeaux* or *biter*. The colouring matter of the gummy resinous kind is soluble in a mixture of ∇ and Spirit of wine only, it cannot be washed from the cloth by ∇ , so bleeds in need of no biter. The resinous dyes require to be diffused in ∇ in w^h they are insoluble when they will communicate their colour to the cloth diffusing into them. Thus Indigo is a resinous substance which requires to be diffused in ∇ by the addition of a δ , when it becomes capable of tinging the cloth previously prepared and diffused into it of a blue colour. After colours are thus applied to cloth some of them turn out more durable than others. In the dying of fleeting and lasting colours is divided into two distinct branches. Wool is apt to catch the colouring matter of plants most readily. Linnen is no way affected by the colouring matter of vegetables, but is readily tinged by that of the animal kingdom. While silk is capable of being dyed by either. From whence this peculiarity arises is not perfectly known. Of the colours dyed by vegetables there is none lasting but the yellow colours, many of them are spoiled by drying the cloth too slowly, the best temperature for drying is at 96° , but even with this degree the

colour will be some what diminished but may in a great measure prevented by drying them in a dark place. Many vegetable colours are heightened or changed by the addition of saline substances. The blue colouring matter is changed to a red by the addition of an acid, & green when we add some of all the & the \odot produces the most florid red. The cause of the change of colour by these additions is owing to the size of the colouring particles being changed by the substances added. an \vee diminishes their size and changes their colour to a red, & if we add an \times slowly so as gradually to change the size of the particles we will get all the colours in succession.

To finish this class of bodies I shall shew you one under the colouring matter of a vegetable of the gummy kind, by the addition of a mordant or binder of a more florid colour, and totally insoluble in \vee . I shall use for this example the colouring matter of the Opuntia or prickly pear collected by the insect Cochineal. Cochineal infused or boiled in \vee , imparts a crimson hue inclining to purple. If to this solution of the colouring matter we add an astringent substance, such as alum, it acts upon the colouring matter precipitating it to the bottom of a crimson colour and insoluble in \vee . Dyers in dying crimson prepare their cloths by boiling it in first in a solution

of alum and crystals of Z , they then dip the cloth in a solution of the colouring matter of cochineal, w^h fixes the cloth of a florid crimson colour. If to the solution of the colouring matter of cochineal we add a solution of Z in aqua regia this precipitates the matter of a beautiful scarlet colour more or less strong. If we separate this powder by straining the fluid thro' blubrous paper, the powder remains on the filter in form of that beautiful coloured substance Carmine. If woven cloth prepared by boiling in a solution of crystals of Z and alum be put into a solution of the colouring matter of Cochineal and a solution of Z in aqua regia be added to the whole the cloth will be dyed of a beautiful scarlet colour. The colour of scarlet is always destroyed by L , hence by washing scarlet cloth with soap its colour is destroyed, and as the dirt of the streets contains some S , hence the parts of cloths that have been bespattered with dirt are always tinged of a blue colour, w^h may be taken out by any weak X .

ANIMAL SUBSTANCES.

I come now to consider a little animal bodies, the history of which will take up very little time as I shall just give the outlines of the subject. All animals are fed either directly or indirectly upon vegetables, & that they are composed of the same principles as vegetables is easily seen by chemical analysis; the only difference is that the soil yielded by vegetable is more agreeable than that got from animal substances; the charred left of the burning too is different, as also the acid saline matter

w^h animal substances yield upon distillation, is different from if
 yielded by vegetables, but this acid seems not to have existed
 originally in the animal substance, but to have been formed by
 the action of the fire during the analysis. However, that an
 acid is contained in some animals is beyond doubt, thus
 ants contain an acid w^h they give out to the v in which
 they are infused, hence we account for the irritation occasioned
 by their bite. The uneasiness occasioned by the sting of the
 bee is owing to an acid the nature of w^h has not been examined.
 It would also seem that the danger arising from the bite
 of some poisonous animals is owing to their transmitting
 into the wound a poison of an acid nature; hence the vipers
 catchers in France cure the bite of that serpent by ap-
 plying Jean De Duce's solution of S with some aromatic oil
 w^h renders the wound a simple solution of continuity.

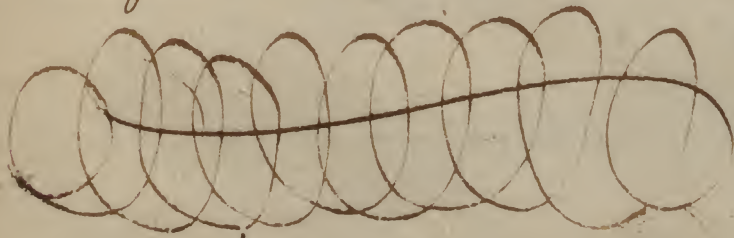
Animal substances differ from vegetables in being sub-
 ject to undergo the putrid fermentation without having
 previously passed thro' the vinous or acetous fermentations.
 Hence it is found requisite in order to preserve animal sub-
 stances from putrefaction to add antiseptics to them, such as
 E O Sugar or Camphor. For this purpose E is far inferior
 to many of the compound salts in antiseptic qualities, even
 small quantities of it, as was formerly added cause the sub-
 stance to turn putrid more readily, hence we account for the
 addition of small portions of it fertilizing the soil.

All animals consist of solid and fluid parts. The solid
 parts are Bones, cartilages, ligaments, muscles, nerves, cellular
 substance &c. The chief of the fluids is the blood, w^h is composed
 of three distinct parts, the serum, crassamentum & red globules
 w^h are differently proportioned in different animals, and in

The same animal at different periods: in inflammatory diseases
From the blood the other fluids are secreted by the organs of
the body; of these fluids there are several, the vital or nervous
fluid appears to be an imaginary one, as it has been much talk-
ed of but never yet seen, the other fluids are the saliva the
gastric juice, milk, bile &c &c are carried to their destined places
to perform their different functions in the animal oeconomy.

The useless degenerated parts of the body, that by their
stay have become acrid, and unfit for the support of the oecono-
my, to hinder putrefaction and ^{acid} state of the fluids taking
place, are secreted from the system by peculiar organs and
thrown out of the body forming the excrementitious fluids,
of the forces, urine & matter of perspiration.

The Books I would recommend in the future
course of your studies besides the publications of Dr Black
Marlow & Macquer, I would also recommend the Chemi-
cal works of Dr Lewis in w^{ch} you will find an excellent treatise
on the vegetable kingdom, & it is I would I might be able to
inculcate to you the perusal of the writings of Dr Keim
or those of M^r Beaumel



THE HISTORY OF THE
CITY OF LONDON
FROM THE FOUNDATION
TO THE PRESENT TIME

BY JOHN STOW
ESQ. OF THE CITY OF LONDON
AND JOHN WARD
OF THE CITY OF LONDON

PRINTED BY I. B. ALDRINE
AT THE SIGN OF THE SHIELD
IN ST. MARTIN'S LANE
1687

A Table of Single

1	⊕	Δ	8	□C	⊘	♂	2	♀	♀	⊕	8	□M	□A
2	⊕	Δ	8	□C	⊘	♂	7	♀	♀	⊕	8		
3	⊕	8	□C	⊘	♂	7	2	♀	⊘	♀	⊕	∇	△

2

4	Δ	8	□C	♂N	♀	7	2	⊕	♀	♂	
5	Δ	♀	∇	∇C	∇						
6	EA	□C	8	□M	8						

3

7	∞	⊕	⊕	⊕	⊕	♀	♀	SS	EA	♀	∇
8	□C	⊕	⊕	⊕	⊕	♀	EA	♀	SS	♀	
9	MS	⊕	⊕	⊕	♀	⊕					
10	7	⊕	⊕	⊕	⊕						
11	∇	⊕	⊕	⊕	⊕						

Elective Attractions

4

12	♂	☿	♂	♀	♂	♀	♂	♀
13	☿	♂	♀	♂	♀	♂	♀	♂
14	♀	♂	♀	♂	♀	♂	♀	♂
15	♂	♀	♂	♀	♂	♀	♂	♀

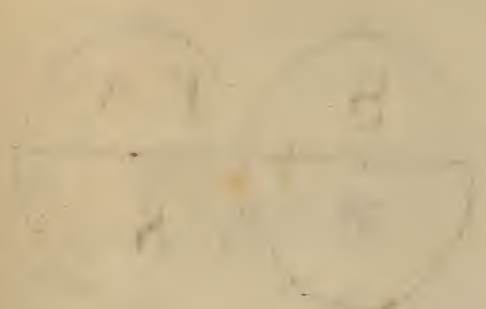
5

16.	▽	8	Imperfectly saturated with air	▽	□	○	Saturated with air and some Neutral Salts
17	▽	▽	△	Resins & Camphore.			
18	Salt of	⊙	⊙	▽			

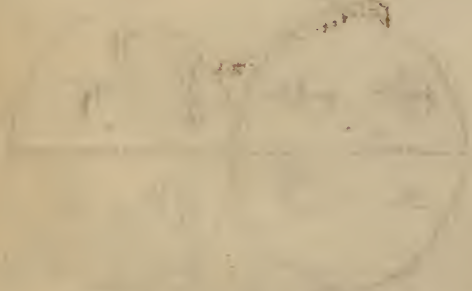
Single Elective Attractions in consequence of Heat

1	8	SS	⊙	⊙	⊙
2	8	RH	⊙	⊙	⊙
3	8	Sil	□	⊙	FA.

!



1 1 2 1



3 3 4 4



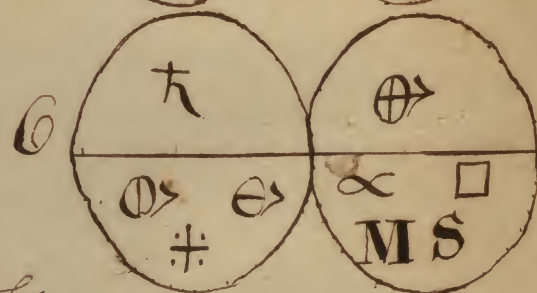
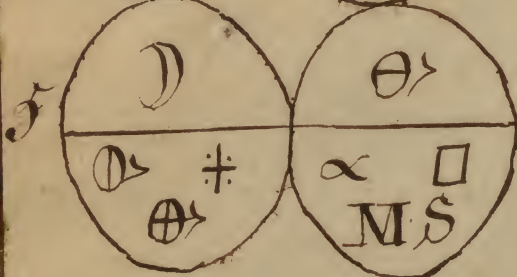
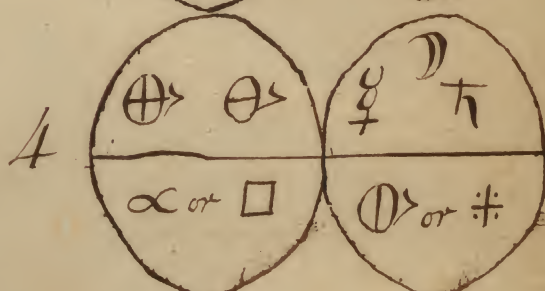
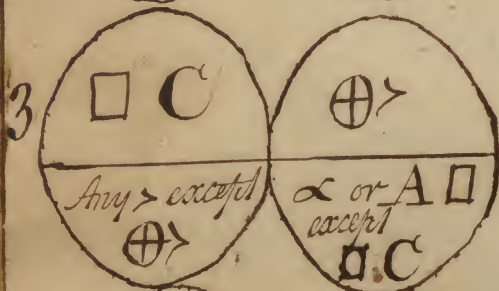
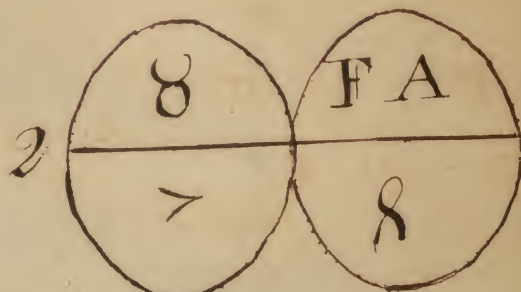
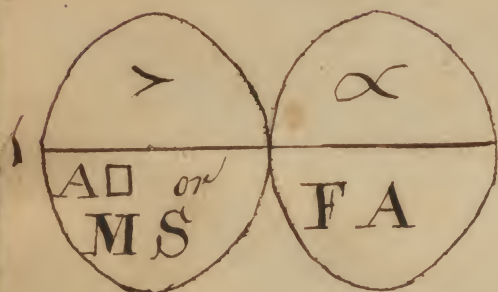
5 5 6 6

II

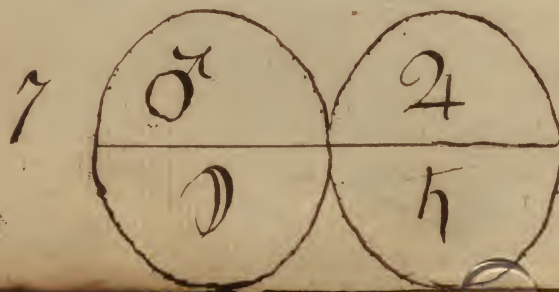


7 7 8 8

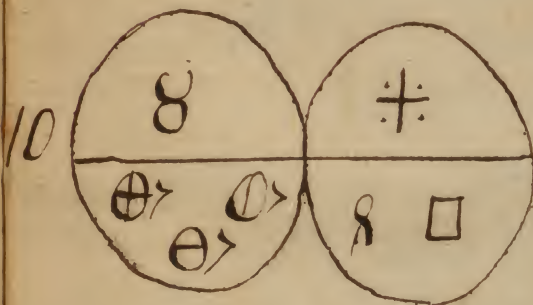
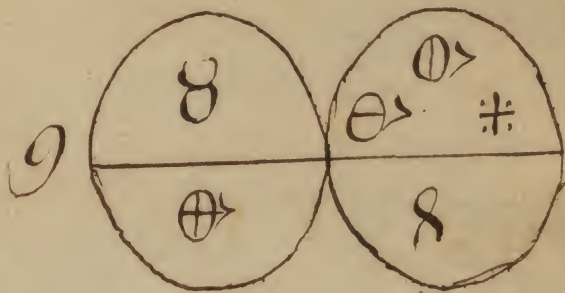
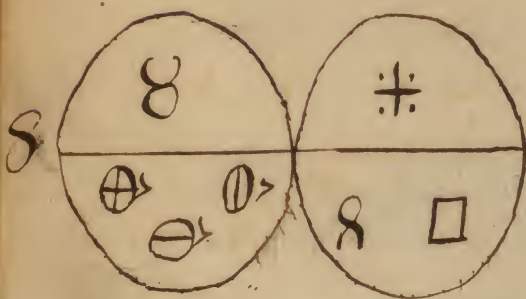
I Double Elective Attractions in watery solids

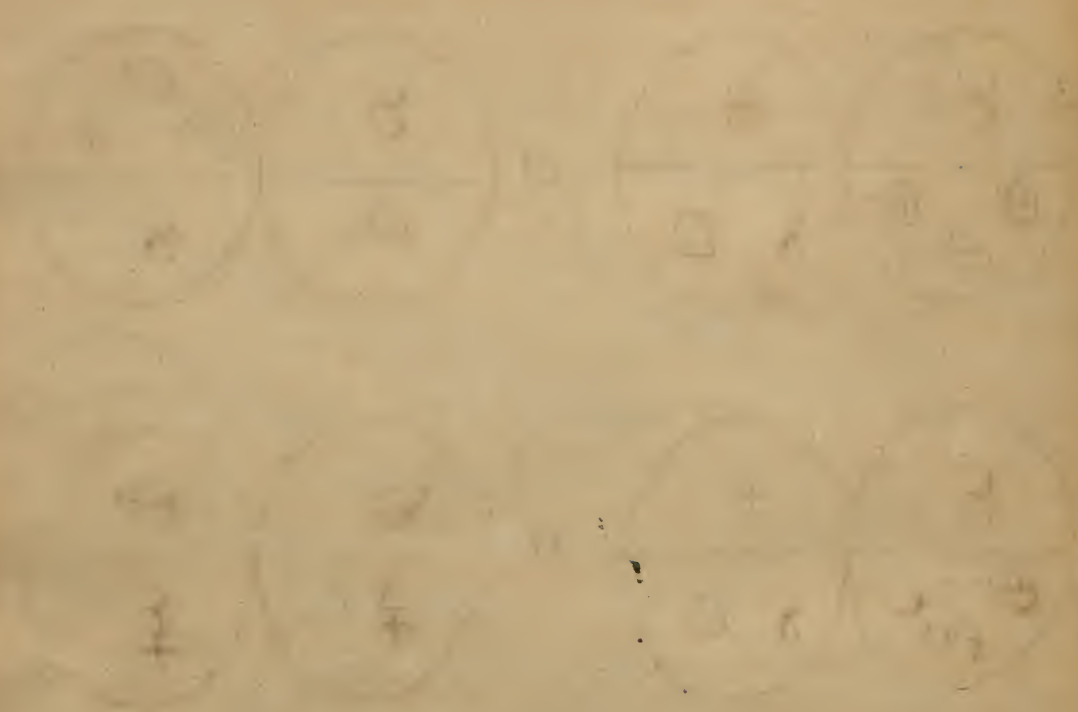


II. By Fusion



III. In Distillation & Sublimation





Explanation of the Tables of Elective Attractions

Elective attractions are of two kinds, single and double. The first is when a substance is added to a compound consisting of two substances, in consequence of which one of these substances separates from the other, and uniting with the one added, forms a new compound. The second is when upon mixing two compounds each consisting of two substances, a mutual exchange of ingredients takes place and two new compounds are produced.

Single Elective Attractions are divided into two kinds 1st Those that take place in the ordinary heat of the weather; & 2^{dly} Those that require the assistance of heat. Those that happen in the ordinary heat of the weather are divided into five heads, as is expressed in the table. The 1st Head shews the order of attraction of different bodies for acids. The 2^d expresses the order of attraction of different bodies for Φ and FA. The 3^d expresses the order of attraction of acids &c for α & \square . The 4th expresses the order of attraction of α & \square for Φ & FA. The 5th shews the order of attraction of different substances, for ∇ & ardent Spirits. The substance for w^{ch} the attraction of different bodies is to be expressed is placed in the first place of the line

and the other bodies follow in the order of their attraction
 When any of the substances can be separated by the
 one ~~following~~ ^{pieces of}, then a line of separation is drawn be-
 tween them, but when this is not the case, the line of
 separation is omitted, & the substance which has seem-
 ingly the strongest attraction is not foremost. Thus
 in the first division we see that the Δ has the strong-
 est attraction for the Θ & next to it the δ ; the Δ however
 is capable of separating from the Θ the δ , it is accor-
 dingly express'd by a line of separation drawn between them.
 The Δ also has the strongest attraction for the Θ , & the
 δ for the Θ . The 2^d Division expresses the attraction
 of different bodies for Δ and Γ . A. There are two ways of uniting
 bodies wth Δ , either by applying it to them in a solid form
 or in form of a hepatic sulphur dissolved in ∇ . The first of
 these is express'd in the Δ line, where we see the δ has the
 strongest attraction. The δ line refers to the hepatics of Δ ,
 the hepatic formed by the δ and Γ can be decomposed by the
 addition of quicklime, that formed by quicklime may
 be decomposed by a δ , & any of them will be decomposed by
 ∇ . The 6th Line shews the attraction of bodies for
 Γ . A. and we see that the \square C has the strongest attraction
 The 3^d shews the attraction of χ^2 for α^2 , \square C and M.S.
 The order of their attraction for metals is generally the
 following 1 Θ 2 Θ 3 Θ , but to this general rule ∇

and Ψ are held two exceptions as expressed in the lines 10 & 11. The 4th Division line 12 & 13 show the attraction of N. S. for Φ and Ψ , by Φ here is meant the white Φ . Line 14 shows the attraction of metals for Φ when they combine in form of amalgamas. \odot seems to have the strongest attraction for Φ but as it does not separate D, Φ & from that metallic substance, the lines of separation are omitted. The 5th & last division, shows the attraction of various bodies for ∇ , Ψ , & salt of \odot w^h is formed by \odot & the \odot . Line 16 shows that Φ imperfectly saturated with air, attract ∇ more strongly than Ψ do, and it is on this that the rectification of spirits proceeds, shows also that we may separate lime from lime ∇ by the addition of spirit of wine. Line 17 shows that by the addition of ∇ , we may separate Ψ & from Φ . Line 17 shows that the \odot has a stronger attraction for \odot than the \odot . Then come the 2^d species of single elective attractions that happen in consequence of heat. Line 1 shows that in this situation the \odot decomposes the \odot \odot & \ddagger . Line 2^d shows that in this situation the Φ decomposes even the \odot , & Line 3^d shows that by the application of heat silicious \odot separate from \odot & F.A. as happens in the making of glass.

Explanation of Double Elective Attractions

Double Elective Attractions are divided into three divisions. 1st Those that take place in watery solutions. 2^{dly} Those that happen in consequence of fusion. And 3^{dly} Those that occur in distillation and sublimation. They are all of them explained by the figures in the table in a very clear and easy manner, so that the explanation of one of them will enable you to understand all the rest with facility. By reading the characters in the longitudinal direction of the oval we learn what are the ingredients of the two compounds before they are mixed. And then by reading in transverse direction we know what are the two new compounds produced, either in consequence of mixture, fusion, in distillation or sublimation. Thus in division 1. N^o 1. By reading in the longitudinal direction of the oval we find the ingredients of the one compound before mixture to be an α combined with an A \square or N. S. & the ingredients of the other compound to be an α saturated with F. A, & in reading in the transverse direction of the oval we learn that one of the ^{new} compounds produced is an α combined with an χ and an A \square or N. S. combined with F. A. So in N^o 2 on mixing a solution of an ammoniacal salt, with a mild δ , the δ of the

ammoniacal salt quits its x , & unites with the FA of the δ , & unites with the x , so that we get a mild δ , and a compound salt consisting of the δ and the x . See in the 3^d On adding a solution of a $\square C$ in any x except the Θ to a compound of the Θ , and any or any \square , except a $\square C$, the x and \square or \square combine together while the Θ uniting with the $\square C$, falls to the bottom in form of a gypsum. In the 4th If we add a solution of a compound of Θ or Θ with any or \square , to one of a compound of γ or δ in the Θ , or of k in \ddagger , a double elective attraction takes place, and we get a compound of Θ or Θ wth γ or δ or k , and one of any or \square with the Θ or \ddagger . & so on in the other two examples. Of these of the 2^d Division w^h happen by fusion I have only given one instance, w^h however is sufficient to illustrate the others w^h happen in this way, tho' their number is not inconsiderable. The one I have given alludes to the refining of δ w^h when mixed wth Θ , as it is often found in the bowels of the earth. If to a compound of this kind we add one of k and γ and melt them in a crucible, the tin combines with the Θ , while the k unites with the δ , from which it can easily be separated by scorification.

The 3^d Division contains those that have been in de-
stillation and sublimation, of this I have given A in-
stances. Fig 8 If we add to an ammoniacal salt
a \square C saturated with F.A., & expose the whole to heat in
close vessels, the \times and \square C unite, and the γ combining
with the F.A. sublimes in great quantity. 9th alludes
to the making of sal ammoniac as it is performed at
Edinburgh! If we add to a vitriolated ammoniac, or com-
pound of δ with the Θ , Θ or \ddagger ; on the application of
heat the δ is separated from the Θ , and uniting with
either of the other acids sublimes to the top, while the
 Θ and \ddagger form a vitriolated γ w^h is left behind.

The 10th Alludes to the making of Spiritus minder-
eri in a solid form. If we add to pure ammoniacal salt
a compound of the \ddagger and a δ or \square , & expose the whole to
heat, the Spiritus Mindereri sublimes to the top in a
solid form, leaving the fopsile \times combined with the δ or \square .

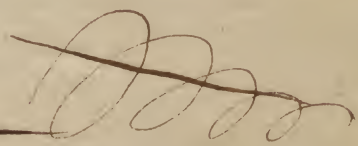
The 11th Alludes to the making of the Butter of anti-
mony. If we add to corrosive sublimate a quantity of
crude antimony w^h is composed of γ and ψ , and expose
the mixture to heat in a retort, a butter of antimony distills
and a factitious Cinnabar is left behind.

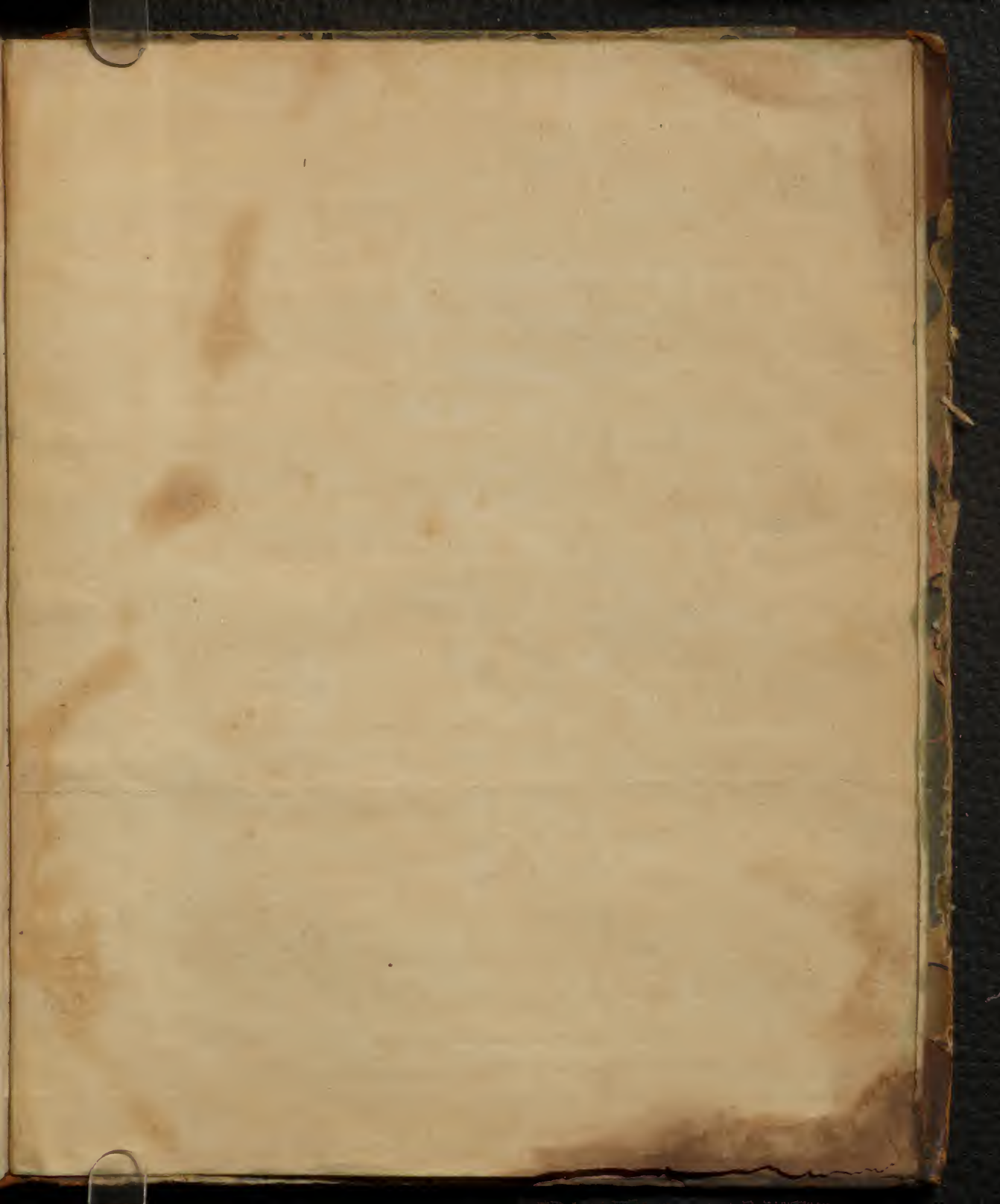
I now gentlemen end these lectures, and wish you
all success in your studies.

Explanation of Chemical Marks —

7, +, Acids in general. V. Vinous Spirits.
 O Vitriolic acid. A Aether.
 O Nitrous acid. OAE Vitriolic Aether.
 O Marine acid. \triangle Aromatic oils.
 ‡ Acetous acid. ∇ Unctuous oils.
 ♀ Tartar. MS. Metallic Substances.
 SS Sedative Salt. O Gold. K Lead.
 PH acid of phosphorus. ∇ Silver. 4 Lind
 & Alkali's in general. P. Platina. O Iron.
 8 Fixt Alkali. ♀ Mercury ♀ Copper.
 8 Volatile alkali. \wedge Regulus of Antimony.
 □ Earth. O Arsenic. B. Bismuth.
 □C Calcareous earth. N. Nickel. Zc Zinc. —
 □M Magnesia. O Vitriol. O Nitre
 □A Earth of Alum. O Sea Salt
 FA Fixt. Air.
 Δ Principle of inflammability
 ♀ Sulphur ∇ Water

Finis





MS.
Acc. 457
v. 2

